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EXHIBIT 557

CORRECTIVE ACTION PLAN FOR OIL POLLUTION ABATEMENT AT RADNOR YARD OF CSX TRANSPORTATION, INC.

RCI Project No. 8-3553.01

July 15, 1990

EDWARD H. HOCKENSMITH II
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 6876
STATE OF TENNESSEE

Resource Consultants, Inc.
7121 CrossRoads Blvd.
P.O. Box 1848
Brentwood, TN 37024-1848
(615) 373-5040

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The staff of the Tennessee Division of Water Pollution Control has determined that the East Fork of Brown's Creek is affected by oils which originate from the Radnor Yard Complex of CSX Transportation, Inc (CSXT) in Nashville, TN. Field investigations by the staff of the Division have revealed an oily sheen on the creek's surface as it emerges from a culvert a slight distance northwest of the intersection of Sidco and Powell Avenues, just downstream from Radnor Yard. Preliminary investigations by CSXT have confirmed that oil- contaminated run-off waters are flowing to the East Fork of the Brown's Creek through a deep, underground storm sewer which originates on the east side of the roundhouse and flows beneath the locomotive servicing complex, car shop, classification yard, and piggyback yard.

The roundhouse, locomotive shop, and locomotive servicing areas are all served by oil collection and treatment facilities which prevent the escape of the vast majority of oily pollutants. However, spills, leakage, and drippage of oils which may have occurred in unprotected areas apparently have entered the storm sewer system at various locations. Some oil contamination may also have migrated downward through the fill materials upon which the tracks are constructed, and may be entering the storm sewers as infiltrating stormwater/shallow groundwater contaminated by surface and sub-surface residual oil.

With the recognition of the oily stormwater discharge problem, CSXT entered into an Agreed Final Order with the Tennessee Water Quality Control Board on June 20, 1990, which provides for abating the polluting discharges to waters of the State at Radnor Yard. One of the provisions of the Agreed Order, which has already been satisfied, involves CSXT filing for an NPDES permit for its discharges to the East Fork of Brown's Creek. A second requirement of the Order requires developing and submitting to the Division, on or before July 15, 1990, a Corrective Action Plan.

The Agreed Order stipulates that the Corrective Action Plan shall:

(a) Provide for interim remedial measures;
(b) Provide for the investigation and mapping of existing sub-surface stormwater and wastewater drainage systems;
(c) Provide for an investigation to establish the aerial and vertical extent of any soil and/or groundwater contamination;
(d) Provide for developing remedial measures, based on the findings of the investigations;
(e) Provide for implementation and/or construction of the final remedial measures;
(f) Include provisions for adequate monitoring by CSXT of discharges and of the receiving waters pending implementation of all remedial design and remedial action measures contained in the plan; and
(g) Include a schedule of implementation.

Resource Consultants, Inc. (RCI) has been retained by CSXT both to prepare the Corrective Action Plan and also to conduct investigations at Radnor Yard in order to develop appropriate abatement strategies. RCI has enlisted the assistance of Golder Associates, Inc. as a sub-contractor to perform geotechnical services associated with the sub-surface investigation portion of the project.

This Corrective Action Plan (CAP) is submitted in response to and compliance with the Agreed Final Order dated June 20, 1990, between CSX Transportation, Inc. and the State of Tennessee Department of Health and Environment, Office of Water Management, Division of Water Pollution Control, Case Number 89-3082, Docket Number 17.30-D-90-0030A.

1.2 ORGANIZATION OF THE PLAN

This CAP has been developed to provide a systematic approach for identifying and abating water pollutants that may be originating at Radnor Yard. In addition, interim corrective measures are proposed to reduce the magnitude of existing contamination problems until appropriate final remedial options can be selected and implemented.

The contents of the CAP have been arranged in a sequence which generally follows the previously listed required elements of the Order. Sections 1 and 2 of the CAP are introductory in nature, providing a discussion of purpose and scope, along with a discussion of site information, respectively. These two introductory sections discuss background conditions and information necessary to an understanding of the proposed investigative and remedial approaches. Sections 3 through 11 of the CAP address the required elements which are listed in Item 11 of the Agreed Order.

2.0 SITE CHARACTERIZATION

2.1 SITE DESCRIPTION

CSXT Radnor Yard is located in the southern section of Nashville, Davidson County, Tennessee. The site covers several hundred acres and is bordered by Harding Place on the South, Trousdale on the east, Veritas (or the extension thereof) on the north, and Sidco on the west. Railroad operations carried out on-site include locomotive fueling and servicing, locomotive repair, railcar servicing and repair, railcar classification (in an automated hump yard), and piggyback: trailer-on-flat-car (TOFC), container-on-flat-car (COFC) loading and unloading. Figure 2.1-1 provides an overall location diagram of the Radnor Yard facility, while Figure 2.5-1 provides a more detailed site map. Overall site topography is shown on Figure 2.1-2. Railcar classification (the hump yard and classification tracks) occurs in the southern and south central portion of the Radnor facility. TOFC and COFC operations occupy the western portion of the facility, locomotive fueling, servicing, and repair occurs in the vicinity of the roundhouse, on the eastern side of the site, as do railcar servicing and repair operations. Oily wastewater generated on-site, along with oil-contaminated stormwaters are treated in a state-of-the-art pollution control facility which is also located on the eastern side of the site.

Access to the site (which is split in half by hump yard railcar classification operations) is available from the east by using the extension of Veritas Street, and from the west by entering off of Sidco on the south near the old Mayton Tower/Hump Yard Tower access road, or on the north by entering the TOFC/COFC access road. Access to the site is closely controlled for safety reasons. Visitors and/or contractors must check in at the appropriate office locations and follow the required safety rules and procedures.

The original terrain upon which the Radnor Yard complex was constructed is the upland hill-and-valley watershed of the East Fork of Brown's Creek. The eastern and southern edges of the site lie along the low ridgeline forming the eastern and southern edges of the East Fork of Brown's Creek watershed. The East Fork of Brown's Creek is an intermittent stream rising from intermittent wet-weather springs and stormwater run-off across the site. Beginning in 1918 and continuing through the years, the site has undergone several significant terrain alterations as the Louisville and Nashville (L&N) Railroad and its successor railroads constructed, modernized, and expanded the Radnor Yard facility.

Today, the feeder branches of the East Fork of Brown's Creek flow through deep underground culverts, exiting CSXT property near the entrance to the TOFC/COFC facility on the northwest side of the yard. Flow in the East Fork of Brown's Creek and the wet-weather springs feeding it is highly rainfall dependent. NO ITS NOT

Weather in the Nashville basin involves the typical hot summer and cold winter temperature extremes with moderate spring and fall temperatures. Precipitation is typically influenced by atmospheric moisture circulated northward from the Gulf of Mexico. Late fall, winter, and early spring rains are often a consequence of cold fronts advancing out of the west or northwest. Late spring, summer, and early fall rains are often associated with afternoon thunderstorm activity. The wetter months are December through May and the dryer months are June through November. March is typically the wettest month and October the driest month. The following chart indicates the average local temperature and precipitation conditions.

Month	Average High	Average Low	Inches Precipitation
January	46	28	4.5
February	51	30	4
March	60	38	5.6
April	71	48	4.5
May	79	57	4.6
June	87	65	3.7
July	90	69	3.8
August	89	68	3.4
September	83	61	3.7
October	72	48	2.6
November	59	38	3.5
December	50	31	4.6

2.2 SITE HISTORY

Construction of the first shops and yard at what is now Radnor began as an integral part of the construction by the L&N of the Lewisburg and Northern Railroad during the period from June 1910, through January 1918. The Radnor complex was located on the southern end of a new connecting line built by the railroad between Maplewood on the north of Nashville, and Mayton, on the south of Nashville, which later became known as the "Radnor Cut-Off". Although the Lewisburg and Northern Railroad was completed by July 1914, conditions which developed during the First World War delayed the completion of the Maplewood to Mayton line along with the shops until early January 1918.

The early shops consisted of a thirty (30) stall roundhouse, ninety (90) foot turntable, and associated watering and coaling facilities for steam locomotives. The yards constructed included classification yards to the north of the roundhouse facility, along with northbound receiving and southbound advance yards to the east and west of the roundhouse, respectively. The original classification yards were constructed to the north of the roundhouse.

The steam locomotives required coal as fuel, large quantities of water for the production of steam, sand for traction, various oils and greases for lubricating the bearings, journals, driving rods, connecting rods, and valve gear. The steam locomotives required routine emptying of the cinders which collected in their ash pans; such was accomplished at Radnor over a cinder pit to the west of the roundhouse. The large coaling tower and coal storage stockpile was located to the northwest of the roundhouse. Water was supplied from Radnor Lake, several miles to the southwest, through a long pipeline, to watering facilities located west of the roundhouse.

The roundhouse was constructed with deep concrete drop pits for removing the driving wheels and axles from the steam locomotives. The drop pits are located in the northern quadrant of the roundhouse. The southern quadrant of the roundhouse contains shallow pits (six feet or less in depth) and/or grade level concrete floors at top-of-rail-elevation. Top-of-rail-elevation in the roundhouse is reported to be 599.42 feet. The roundhouse was apparently built with foundation piers or piles extending to bedrock some twenty (20) to thirty (30) feet below grade. Earth excavation and earth fill operations were probably involved in the construction of the roundhouse complex. Examination of archived drawings, old photographs, and some recent soil boring logs indicate fill areas to the east, west, and south of the roundhouse complex.

Significant quantities of fuel oil were not stored at Radnor Yard until dieselization of the Louisville and Nashville Railroad. Although the first diesels on the L&N were purchased in 1939 (these were two switching locomotives of only 600 horsepower each and were used in the East Louisville Yards) the L&N did not begin replacing steam power with diesel power until 1946. Most of the dieselization of the railroad occurred between the years 1950 and 1957 as the following table shows.

DIESELIZATION OF THE L&N RAILROAD

YEAR	DIESELS ACQUIRED
1946	9
1947	0
1948	6
1949	29
1950	99
1951	116
1952	74
1953	75
1954	49
1955	20
1956	60
1957	138*

*all of these were acquired in the merger of the NC&StL Railroad.

The L&N became completely dieselized on November 3, 1956 at which time diesel power had almost completely replaced steam power on the railroad (the last official steam powered run on the L&N was January 28, 1957). During the transitional years of dieselization on the L&N, servicing and shop facilities had to service, maintain, and repair both steam and diesel locomotives. Diesel fueling facilities were required at all major servicing areas and Radnor was no exception. A two hundred fifty-nine thousand (259,000) gallon diesel storage tank was erected to the west of the northern quadrant of the roundhouse in 1953. Fueling operations took place on aprons west and slightly north of this area. Modernization and expansion of the servicing area would later see the abandonment and removal of these early diesel fuel storage and fueling facilities.

The middle 1950s saw the construction of a major railcar classification yard at Radnor, south of the previously existing yards and the roundhouse/servicing facilities. The new yard was a major undertaking and featured gravity car classification using track-mounted car retarders. The new yard contained over one hundred miles of track and could handle three thousand cars a day. Construction of the new classification yard required a major amount of cut and fill in the area to the south and west of the roundhouse complex. Large diameter culverts for conveying stormwater runoff were extended several thousand feet to the west toward the East Fork of Brown's Creek, laid in the channels of what were once stormwater drainage ditches and intermittently flowing stream channels conveying storm water to the East Fork of Brown's Creek. The vast, flat surface area of the new classification yards belies the existence of these large diameter storm sewers some twenty to thirty feet beneath the ground surface.

The middle to late 1950s also saw construction of diesel servicing facilities to the south of the roundhouse, along with a diesel locomotive repair house, and a new, 500,000 gallon diesel fuel storage tank. The new fuel storage tank was located in the low area south-southeast of the roundhouse. Also located in that low area, at the head of the main storm drain which flowed westward to the East Fork of Brown's Creek, was an oil skimming pond which was apparently the railroad's initial attempt at containing oils spilled at the facility.

The late 1960s and early 1970s saw increasing pressure brought to bear against the L&N Railroad by the Tennessee Stream Pollution Control authorities to prevent oily waters from being discharged into the East Fork of Brown's Creek. In the early 1970s the railroad constructed a pollution control plant consisting both of physical and chemical processes to help eliminate the problem with oil spills. Although the problem in the creek abated somewhat over the ensuing several years, it became obvious that a major enlargement, expansion, and modernization of the original pollution control facilities would be necessary.

In the early 1980s the L&N Railroad undertook a multi-million dollar project to completely rebuild and expand the oily wastewater pollution control system at Radnor Yard. The new water pollution control facilities included new industrial sewers which segregated the oily wastewaters containing primarily emulsified oils from the oily wastewaters containing primarily free oils. A new sewer system was installed which intercepted the emulsified oily wastewaters originating in the roundhouse and the emulsified oily wastewaters originating in the diesel engine house. A new pair of diesel locomotive service pits and fueling aprons were installed, along with a new, automatic locomotive wash facility; a new industrial sewer collecting the potentially emulsified oily wastewaters from these new servicing facilities (and the intervening track pans) was constructed, which connected to the new trunk sewer conveying the emulsified oily wastewaters to a new physical-chemical treatment system for emulsified oily waste. Track pans were also installed on the diesel locomotive engine house leads (tracks) to the south of the engine house, and on the ready (waiting) tracks to the west of the new service aprons. Along with the new track pans which collected the free oils which leaked or dripped from idling, stationary locomotives, a new free oil industrial sewer was installed to convey these wastewaters to a series of lagoons to the southeast of the roundhouse area. These lined lagoons contain baffled chambers and oil skimmers to remove the floating free oils to oil recovery sumps from which they are pumped through underground lines to aboveground recovered oil storage tanks.

The smallest of the two free oil recovery lagoons is concrete lined and contains three baffled chambers: one for grit recovery, one for primary recovery of floating oils, and one for secondary recovery of floating oils. The treated effluent from the primary lagoon flows into the larger secondary lagoon which is lined with an oil-resistant synthetic membrane and operates as an equalization chamber feeding a vertical tube coalescing oil separator by gravity through control valves. The effluent from the vertical tube coalescer (which can operate at a nominal 90 gpm rate and a peak rate of 200 gpm) flows to the treated effluent lift station from which it is pumped into the Metropolitan Nashville sanitary sewer.

The emulsified oil wastewater treatment system consists of chemical feed pumps, mixers, mixing chambers, and a dissolved air flotation system which floats the oils which are released when the emulsion is chemically broken. The treated effluent from the dissolved air flotation system also flows to the treated effluent pump station where it also is pumped to the Metropolitan Nashville sanitary sewer.

Another feature of the new oily wastewater treatment system was an oily sludge treatment and dewatering system consisting of storage and equalization tanks and mixers, chemical storage and mixing tanks, chemical feed pumps and a precoat (diatomaceous earth) vacuum filter upon which the chemically conditioned oily sludge is dewatered to a semi-dry cake for disposal.

The new wastewater treatment facilities constructed in the early 1980s are located in the low area to the south and east of the roundhouse. Associated with these facilities are track pans on sludge car unloading tracks to the east as well as track pans and a concrete curbed unloading apron at the lube oil loading/unloading area east of the roundhouse. The new wastewater treatment facilities and the associated track pans and collecting sewers installed in the early 1980s substantially reduced the amount of oils being released into the environment in Radnor Yard. However, some oils continued to escape and reach the main storm drain running east to west beneath the diesel engine house, service aprons, and car shop, whence it flowed toward the East Fork of Brown's Creek.

In 1977, as a preliminary construction feature installed in advance of the new pollution control treatment facilities, a spill prevention lagoon was constructed in the low-lying area adjacent to the East Fork of Brown's Creek just upstream from the point at which the East Fork entered a culvert and passed beneath Sidco Drive. This spill prevention lagoon had an earthen bottom and sides, with concrete erosion protection side slopes extending from just below the potential low water level to the top of the lagoon embankments. The lagoon served as a gravity oil/water separator and contained an oil skimmer to remove the floating oil and a pump which was periodically used to transfer the recovered oil up the bank to an awaiting tank truck for recovery or disposal. The spill prevention lagoon on the west side of the yards served as a significant oil recovery facility during the time when the new oil collection and treatment facilities were being installed in the locomotive servicing areas.

After completion of the new pollution facilities in 1983, the spill prevention lagoon on the west side of the yard was taken out of service in order to construct the new trailer-on-flat-car/container-on-flat-car piggyback yard.

At that time, in an effort to contain the oils which were still escaping down the main storm sewer to the East Fork of Brown's Creek, a baffled manhole and recycling lift station was constructed just west of the car shops and east of the eastern-most tracks in the classification yard.

The new TOFC/COFC facility constructed in 1982 and 1983, completely changed the topography of the valley of the East Fork of Brown's Creek within CSXT property boundaries. The entire valley was filled and the East Fork of the creek was placed in a concrete culvert beneath the truck trailer parking area. The storm drains originating on the eastern side of the site were continued in lines along the valley floor, combining with the flow in the East Fork of Brown's Creek at a fifty (50) feet deep manhole, whence all of the flow was piped through the previous location of the spill prevention lagoon to the culvert carrying all of the stormwater flow (as well as the intermittent flow of the East Fork of Brown's Creek) beneath Sidco and eventually emptying into the open channel of the East Fork, several hundred yards downstream.

2.3 REGIONAL CONDITIONS

2.3.1 Regional Physiography

The site lies in the southern part of the Inner Blue Grass region that stretches from central Kentucky through north-central Tennessee (see Figure 2.3-1). This broad physiographic province is partly underlain by biogenic limestones and calcareous shales of late Middle Ordovician age. In Tennessee, the strata are assigned to the Carters, Hermitage, Bigby-Cannon, Leipers and Catheys Formations, of the Richmond Group in the Central Basin (of U.S. Geological Survey nomenclature or Nashville Basin, of Wilson, 1935).

This basin, which is roughly elliptical in shape, is a classic example of inversion of topography, for the area is structurally high but topographically low. The basin was formed by the erosion of a low structural dome, the Nashville Dome. Most of the basin lies between altitudes of 500 feet and 700 feet above mean sea level (MSL), in contrast to the Inner Blue Grass region that is consistently 300 feet to 400 feet higher (see Figure 2.3-1). The lowland, which coincides very closely with the axis of the topographic inversion, is rimmed by the infacing Highland Rim Escarpment. The limestones which form this escarpment were brought to the surface, in limited exposures, by the Nashville Dome, which lies astride the Cincinnati arch. The arch forms the backbone for the Blue Grass physiographic region, (Thornbury, 1965) (see Figure 2.3-1).

Limestones form the lowlands in the central portion of the basin. The topography in this area is that of a moderate karst plain, locally bedrock being exposed in flat pavement called "glades". The majority of the karst features occur as sinkholes over solutional openings through the relatively thin soil regolith. The soil comprises residual "in-situ" regolith or alluvial material transported in during the fluvial downcutting by the Cumberland River and its tributary streams. This broad, gently rolling lowland averages about 600 feet MSL, and lies about 200 feet above the elevation of the Cumberland River.

Groundwater conditions in the site area effect karst development. The Cumberland River and its two main tributaries, Mill Creek and Stones River are the only perennial streams of significance in the area. The difference of almost 200 feet from the mean elevation of terraces along the Cumberland and the rolling topography of the lowland serves as an index of the elevation-gradient component contributing to groundwater flow in terms of karst development. Groundwater flow may well occur below the pool level of the Cumberland River but this deep circulation can be considered of little importance to karst development in the lowlands.

2.3.2 Regional Geology

The Nashville Dome is a broad anticlinal structure that forms the southern part of the Cincinnati arch which occupies all of central Tennessee (see Figure 2.3-1). The dome culminates in southcentral Rutherford County. From this highest point, the strata in the dome dip about 8 feet/mile (1.52 meters/kilometer) to both the southwest and northwest. The average dip to the northwest is somewhat steeper at 16 feet/mile (3.3 meters/kilometer).

The site is located on the northwestern limb of the dome to the south of the outskirts of the city of Nashville. The youngest strata of the dome structure occupy the bluff slopes on isolated knobs of the Highland Rim Escarpment. Successively older formations occupy the lowlands and valley walls of the entrenched drainage systems feeding into the Cumberland River.

The local bedrock comprises a relatively monotonous succession of late Middle to early Upper Ordovician carbonate strata which are locally faulted. Overlying these carbonates is a Devonian-Mississippian package of clastic sedimentary rocks comprising the Chattanooga Shale and the siltstones, shales, and mudstones of the Mississippian Fort Payne Formation.

The oldest outcropping formation in the area is the Carters Limestone. Figure 2.3-2 provides a map of the geology in the vicinity of the Radnor Rail Yard. The best outcrops of this formation occupy the valley of Sevenmile Creek. The basal members of this formation are massive bedded lime mudstone which are as much as 80 feet thick. These strata are separated from the upper member by a thin 6 inch to 12 inch bed of bentonite (the "pencil cave" of drillers in central Tennessee). It is noted that this layer may well form a local aquitard, retarding groundwater percolation into the basal member. The upper member of the Carters Limestone is generally 10 feet thick and comprises thinly-bedded limestones with shale partings.

Overlying the Carters Limestone is the Hermitage Formation which comprises a basal limestone followed by a laminated, argillaceous, sandy limestone which is the thickest member (50 to 70 feet) of the Hermitage. Further upsection is a bioclastic limestone which is laterally discontinuous and not more than 10 feet thick. The upper most member of the Hermitage Formation is a granular phosphatic sandy limestone that is also variable in thickness. The Hermitage is about 50 to 90 feet in overall thickness. It occurs as broad ledges on the valley walls surrounding the floodplain of Sevenmile Creek and forms a floor to the different branches of Brown's Creek (see Figure 2.3-2).

The Bigby-Cannon Limestone overlying the Hermitage is an upward fining limestone sequence consisting of massive bedded, somewhat phosphatic sandy limestone of variable thickness overlain by a massive to medium bedded lime mudstone which is as much as 30 feet thick. The Cannon limestone facies is the next member of the formation. It is evenly bedded, medium bedded lime mudstone. The overall formation thickness ranges from 70 to 150 feet, thickening eastward. This formation forms the bedrock for the lowland karst plain.

The Leipers and Catheys Formations form bluffs in the remnant knobs of the Highland Rim Escarpment that surrounds the lowland plains. This formation, which is as much as 175 feet thick, comprises shaley, nodular, argillaceous, thinly-bedded fossiliferous limestones. Capping these remnants of the Highland Rim Escarpment are the Devonian-Mississippian age Chattanooga Shales and the Mississippian age Fort Payne Formations.

Faulting in the Nashville Dome is not common, but small normal faults do occur. These structures are generally steep dipping (60 to 80 degree dips). Vertical displacements range from 330 feet but more commonly, displacements are about 50 feet. Most of these faults are so poorly exposed that rarely can they be followed over a ground distance of more than several kilometers.

The strata in the Nashville Dome are fractured by regionally recognizable joints. Local joint concentrations may increase as the many secondary flexures that occur on the flanks of the dome are approached. Joint intensity as measured by their spacing, increases with the decrease in bedding thickness (as in the platy, argillaceous and thinly-bedded limestones). Through-going and persistent joints that form part of regional sets are generally well spaced, and best developed in the more thickly or massively bedded carbonates. The joint pattern in most of the northern flank of the Nashville dome is fairly consistent, mostly vertical. The sets forming this pattern trend N55-65 W and N35-45 E. In the Nashville area (Nashville West Quadrangle) however, the joints occur in two sets, N30 E to N10 W, and N62 W to N80 E (Wilson, 1948). This wider azimuthal spread suggests that the entrenching of the Cumberland River nearby has superposed stress-release joint sets on the regional joints. However, as one approaches the CSXT site farther to the south, stress-release jointing may be absent.

The effect of this pervasive jointing is expressed in the structural control of drainage patterns in the area (see Section 2.3.3).

2.3.3 Regional Hydrology

2.3.3.1 General

As discussed previously, the site area is known to be underlain by strata which have developed a karst hydrogeology. Within such a system, groundwater may preferentially flow via conduit and cave systems rather than through the pores of the rock material or through pervasive and ubiquitous material fractures systems.

An extensive literature base on karst in general, clearly shows that caves and other groundwater flow conduits in carbonate rocks are frequently the result of solutional enlargement of secondary permeability features such as bedding planes or joints. Sinkholes are the surface expression of the presence of these subsurface phenomena. An important factor in the development of these features is the initial secondary fracture permeability prior to karst development. This secondary permeability is then preferentially developed along specific fractures as a result of groundwater flow moving towards the surrounding entrenched stream valleys, and surficial runoff infiltrating into overburden and bedrock material, sinkhole swallets, and enlarged fractures (joints). Other factors that may require definition for understanding of karst areas are bank-storage, static groundwater levels, and the degree to which cavern systems are multi-levelled and interconnected. However, a careful field study of the surface karst features, joint patterns (their intensity, spacing, openness or tightness, their azimuthal distribution and relationship to lithostratigraphic units) and drainage characteristics at springs etc. is required to allow understanding and prediction of groundwater flow. Consequently, determining groundwater flow systems can be problematic.

Preliminary analysis of a karst environment may be based on a thorough understanding of the stratigraphy and structural geology of an area. To provide the necessary guidance for development of a work plan for study of the CSXT site preliminary analysis has been made of the following data:

a. Regional Karst Hydrology
b. Topographic Maps and Drainage Systems
c. Structural Geology
d. Regional Aeromagnetic and Gravity Maps
e. Aerial Photographs

2.3.3.2 Regional Karst Hydrology

The karst topography and hydrology of the northern flanks of the Nashville Dome have been well studied in Montgomery County farther to the northeast of this area (see for example, Kemmerly, 1981). Very little is known about the karst in Davidson County. A few caves and springs have been reported in the Nashville area but not much by the way of geologic detail can be gleaned from these published reports. Sinkholes and cave passages in Montgomery County have been shown to be strongly structurally controlled by N20 E to N40 E and N10 W to N30 W trending joint sets. It is, therefore, highly likely that the flow in the CSXT Radnor Yard area is controlled by fracture permeability.

Lack of sinkholes in a karst setting (area underlain by soluble strata) is due primarily to the efficiency of the subsurface fracture-drainage system. A high permeability area is typically classified as one having a large number of open, interconnected fracture systems. Water quickly percolates into the system through the soil cover hence sinkholes are generally absent.

A perusal of the topographic maps of the site surroundings shows that the western branch of Brown's Creek south of David Lipscomb College campus (Oak Hill Quadrangle) is a rejuvenated blind valley exposing the Hermitage as a window through the Leipers and Catheys Formations. In the Antioch Quadrangle, a tributary to Sevenmile Creek (one half mile northeast of Providence) sinks into the upper part of the Carters Limestone and emerges farther downstream. A further examination of the geologic maps shows that sinkholes are not uncommon in the lowland plain. In fact, several large sinkholes have been indicated on the geology map of the site (see Figures 2.3-2 and 2.4-2). These observations suggest that the area may be considered either a moderate or low permeability karst terrain. Only detailed field study will provide this data. In areas of moderate permeability, groundwater flow is concentrated into fewer joints that are open and amenable to vadose circulation. Such a scenario would result in aligned sinkholes at the surface and fracture-controlled conduit systems. The fact that several of the sinkholes near the site have been reported to have ponded back and held water for some duration of time suggests that not all joints are open enough to quickly transmit sudden storm or protracted runoff events. When the permeability of joints is decreased by saturated conditions or inherent slower permeability in the joint fill material, groundwater may quickly move to lateral flow, i.e. flow along bedding planes. All the carbonates in this site area are conducive to bedding plane transmission of groundwater. A search of the literature on caves and springs in the Nashville area shows that the Hermitage Formation supports a fairly large bedding plane-spring population. Preliminary assessment of the elevations of springs in the local areas around the CSXT Radnor Yard supports this observation.

The above tentative interpretations are not hard and fast rules for the karst type in the site area and should be viewed at this stage as speculative.

2.3.3.3 Interpretation of Local Area Topography

Preliminary analysis of the drainage pattern in the area surrounding the site has allowed the development of a drainage map (Figure 2.3-3) that contains all drainage lines that can be drawn on the topographic base. It also includes features that have been interpreted to be sinkholes and other karst features. Sinkholes have been interpreted where anomalous topographic contour patterns occur in an otherwise regular pattern. The drainage pattern analysis provides for a first order approximation of possible structural controls on the drainage lines (Figure 2.3-3). The criteria used to determine structural controls on streams are the alignment of stream segments along rectilinear paths. Examples are numbered on the map. These examples are interpreted and referred to as "zones" of structural importance because they parallel changes in the structure contours drawn to the strata (see Figures 2.3-5 to 2.3-10).

Alignment of headwater stream segments across drainage divides are outlined on Figure 2.3-3. The symbols for these alignments are based on the confidence of interpretation. Solid lines are most confident, whereas dotted lines are simple extrapolations between linear segments of streams. Solid lines with bars are interpreted to denote joint-controlled stream valley-sides.

Three prominent stream alignments are apparent. They are a northwest, north-south, and northeast-southwest-trending.

a. Brown's Creek set trends N 330 degrees and can be traced into the collinear alignment of the headwaters of Sevenmile Creek. This northwest trend is noted in a broad zone along Brown's Creek; and may be a fault zone or a broad zone of flexure in the underlying strata. If this is a fault zone, the relatively elevated block would be to the northeast of the Brown's Creek alignment.

b. The northeast Sevenmile Creek trend N 050 degrees appears to be a strong alignment of joints that have been occupied by various roaches of the Sevenmile Creek. Since this creek has widened its valley, the bluffs adjoining the valley floor reflect the strong joint control. This preferential erosion may explain the steeper gradients of smaller order streams flowing into Sevenmile Creek. Streams to the west and northwest of the site generally have gentler gradients.

c. The third alignment is a north-south set. A particularly strong set can be seen in the southwestern part of the map area. This set cross-cuts the other two sets and is occupied by smaller order streams. It is speculated that this set is the youngest fracture orientation.

A rose diagram has been constructed utilizing length-weighted segments of the rectified drainage trend interpretation (see Figure 2.3-4). Instead of counting numbers of aligned stream segments, one kilometer segments along the alignments were counted. This allowed for compensation of the relatively long single alignments such as Brown's Creek.

2.3.3.4 Structural Interpretation of Geologic Map

The strata are generally flat lying in this area. Dip values, as measured off the geologic map, range from 5 to 10 degrees, generally to the northwest and northeast. Using the geologic map as a base, structure-contour maps were constructed. The formation boundaries which have been contoured are as follows:

a. Top of the Carters Limestone (see Figure 2.3-5)
b. Top of the Hermitage Formation (see Figure 2.3-6)
c. Top of the Bigby-Cannon Limestone (see Figure 2.3-7).

Figure 2.3-5 presents the interpreted structural contour map of the top of the Carters Limestone. The Carters Limestone occupies the valley floor and walls of the Sevenmile Creek. A steepening of dips to the northwest is noted in the east-central part of the area. The structure contours then swing to the south as they approach the Brown's Creek alignment, where the dips generally flatten out. Note, however, the structural low along the Brown's Creek trend. It is for this reason that the Brown's Creek alignment has been interpreted as a structural feature (fault or flexure). Overall, the Carters Limestone subcrop appears to be strongly controlled by the Sevenmile Creek trend modified by the Brown's Creek trend.

Figure 2.3-6 presents the interpreted contour map of the top of Hermitage Formation. This formation underlies the broad topographic flat between Brown's Creek flowing north and Sevenmile Creek which drains the southern portions of the area. The surface drainage divide approximately follows the eastern boundary of the CSXT site. The structural contours display a complex system of both broad and narrow amplitude flexures (highs and lows) on the top of the Hermitage. Northwest-trending flexures parallel similar trending structures in the underlying Carters Limestone; i.e., parallel to Zones 1, 2 and the Brown's Creek trend. The patterns further suggest that an elevated block lies northeast of Zone 2.

Northeast trending flexures are generally narrower. Three of these can be seen cutting across the Brown's Creek alignment. These structures appear to be similar to those interpreted at the top of the Hermitage Formation (see "Geology of Nashville" Bulletin 53 of the Tennessee Division of Geology).

Figure 2.3-7 presents the interpreted structural contour map of the top of the Bigby-Cannon Formation. Since the Bigby-Cannon underlies the broad topographic flat in the central study area, structure contours were drawn to the base of the few remnant outcrops of the Leipers and Catheys Formations. The limited outcrop precludes a detailed interpretation. Broad wavelength northeast trending flexures are apparent.

Figure 2.3-8 presents the broad scale interpretation of the structural geology in the site area. From a combined interpretation of the structural contours drawn to the top of the Hermitage Formation and those on top of the Bigby-Cannon, it appears that the present topographic high and surface-drainage divide approximately parallel a northeast trending broad wavelength flexure in the underlying strata. This flexure might be a monoclinal structure with the elevated block to the southeast. If this interpretation is correct, then the Sevenmile Creek trend might indicate a zone of fractures preferentially developed on the flanks of the monocline.

2.3.3.5 Aeromagetic and Gravity Maps

The aeromagnetic and Bougeur gravity anomaly maps (see Figures 2.3-9 and 2.3-10) display remarkably consistent patterns in the trends and gradients of the anomalies. These anomalies display the Precambrian basement "fabric." The fabric is quite similar to the surface drainage alignments noted in previous figures.

If indeed these patterns are similar, then some type of fracture propagation of basement block-bounding faults into the overlying Paleozoic platformal cover within the Nashville Dome must be invoked. These propagation zones most probably display themselves in the cover as zones of intense jointing, which later play an important role in controlling stream alignment and probably the development of karst flow features.

Key gravity and magnetic anomalies (A, B and C) have been identified on both maps.

Anomaly-A, is a coincidental gravity and aeromagnetic low anomaly. It is bounded by steep gradients along its northeastern and southwestern flanks. Anomaly-C, better expressed on the aeromagnetic maps, lies beneath the CSXT site, and parallels the Brown's Creek trend. The southwestern gradient on anomaly-C coincided almost directly with the Brown's Creek trend. The gradient is to the southwest in the aeromagnetic map, this indicates that the northwest-trending positive anomaly is relatively upthrown with respect to the southwestern side of the anomaly along a northwest-trending high-angle fault. The gravity map does not display this feature as well; it should be noted that the axis of anomaly-C is entirely coincident on both maps. It may be possible that the density contrast across the northwest-trending fault (see aeromagnetic map Figure 2.3-9) is not high enough to resolve at the scale of the gravity anomaly map.

The maximum compression stress principal axis drawn on both maps is data obtained from Craddock, J.P., and van der Pluijm (1989, Geology v.17, pp. 416-419; Late Paleozoic deformation of the carbonate cover of eastern North America). This trend clearly parallels the major northwest-trending fabric. If may be that a casual link can be developed between the northwest-trending joint fabric in the Nashville carbonates and extensional (tension) fracturing during the Late Paleozoic. This fracture orientation may express itself as the major joint sets in the site area carbonates.

2.3.3.6 Photogeologic Study

The presently available aerial photographs (1976 and 1986) are of limited use fundamentally because of limited coverage (they only display the Radnor CSXT site). Extensive urbanization in the area immediately surrounding the site further made interpretation difficult. Large areas were covered by fill-material or residential-industrial developments. Where possible, interpretations of outcrop and karst features are made.

The preliminary comments below are provided to identify possible interpretive levels.

The open fields to the east of the CSXT site are characterized by mottled tonal patterns indicating changing soil conditions. These mottled ground conditions are present within topographic hollows occupied by a dry-stream bed. Typically, in areas underlain by carbonate rocks, such patterns signify karst features overlain by moist soils; hence the dark tones. The lip of these solution cavities is usually overlain by better drained soils; hence the lighter tones.

In the open field farther north, two areas have been avoided by the farmer. These features may be sinkholes. The large area of mottled ground in this field can be apparently traced to the oil storage tanks located at the northern end of this field. Unfortunately this area is not imaged in the 1984 coverage.

Aerial photograph interpretation using better and older coverage is considered to form one of the initial work plan tasks.

2.4 SITE GEOLOGY AND HYDROLOGY

Information on the topography and geology at the CSXT site is limited. The site's initial topographic and geologic features have been significantly altered by construction activities. The following description is based on information obtained from the geologic and topographic map of the area, limited borings conducted for construction purposes, and existing references. Figures 2.1-1 and 2.1-2 provide site location and topographic information. It should be noted that the USGS geologic map provides topographic contours prior to the extensive site modifications completed in 1982-1983.

2.4.1 Site Surface Soils

Surface soils in this area are categorized by the USGS as belonging to the Maury series. The site soils, identified as Maury-Urban land complex, 2 to 7 percent slopes, are well drained and formed in residuum of phosphatic limestone or old alluvium and residuum of phosphatic limestone. These soils occur on the outer part of the Nashville Basin. Typically, the thin surface layer of Maury soils (about 6 inches to 7 inches thick) is a dark brown silt loam underlain by up to 65 inches of brown and reddish brown to yellowish brown, firm silty clay. In a few areas, the subsoil is brown clay and less than 40 inches thick over bedrock. The disposition of surficial soils is provided in Figure 2.4-1.

These soils have probably been significantly disturbed at the site by cut and fill activities, during the site's development and make up part of the fill directly overlaying bedrock or in contact with previously existing soils over bedrock. This soil's description is generally consistent with that used for the clays encountered in the borings on the east side of the site, where it was found mixed with the fill and at the bedrock overburden interface.

2.4.2 Site Geology

Bedrock in the area is flat lying Bigby-Cannon Formation overlying the Hermitage Formation. The older Hermitage Formation outcrops on the west side of the site forming the floor of the tributary stream valleys to Brown's Creek (see Figure 2.4-2). The eastern portion of this valley has been backfilled with bedrock fill in order to construct the existing rail lines and tractor-trailer parking area. The eastern, northern, and southern portions of the site are probably underlain by the Bigby-Cannon Formation and the overburden in these areas has also probably been modified.

Limited construction borings were performed in the vicinity of the retention basins (see Figure 2.4-3) in 1977 and the wastewater treatment facilities in 1978. Their location roughly coincide with the speculated sinkhole area on the eastern portion of the site (See Figure 2.4-2). The logs for the retention basin borings indicate that the mixture of fill and clay in this area is 10 to 40 feet thick. The top of bedrock inferred from these logs ranges west to east, from approximately 553 to 577 feet above mean sea level. The logs for the borings in the treatment plant area indicate a fill thickness of 5 to 25 feet consisting primarily of cinders and sand. All borings encountered brown silty clay underlaying the fill followed by bedrock as indicated by auger refusal. The elevation of bedrock in this area ranges from approximately 561 to 570 feet above mean sea level.

The clay layer at bedrock was less continuous in the retention basin area, and voids and solution channels were encountered in the uppermost bedrock in the retention basin area. The drilling fluids were lost in several of these borings and saturated conditions were not indicated. The boring logs for the wastewater treatment plant area indicate that a continuous clay layer approximately 2 to 10 feet thick overlays bedrock. Saturated conditions were reported at the clay layer with a water level at or just above the top of clay.

Just to the north of the treatment plant, three borings were advanced through fill in association with the removal of lube oil storage tanks in 1990. Auger refusal occurred at 27.5 and 17.3 feet in the south and north boring respectively (Figure 2.4-3). The topmost 19 to 20 feet consisted of black sand and cinders with traces of clay and oil. Light brown sandy to silty clay was encountered prior to refusal. The third boring to the west of the used oil storage tanks encountered the dark brown sandy clay at 22.5 feet and was terminated at 27.5 feet in clay with chert.

Other geologic features of interest at the site include the possible sinkholes. As noted in the discussion of local geology, sinkholes are common in the site area and several such existing features around the site have been tentatively identified from aerial photographs. The geologic map indicates that at least three such sinkholes were visible on the site prior to the construction of the rail yard. These sinkholes are presumed to now underlay the east spurs of the rail yard and the oily wastewater treatment plant area (see Figure 2.4-2) on the eastern boundary of the site. The relationship of any sinkholes to other hydrogeologic features on the site, such as the East Fork of Brown's Creek, is unknown at the present time.

No further subsurface information on the rail yard and tractor-trailer fill areas was available at the time of this review.

2.4.3 Preliminary Hydrogeologic Model

The broad topographic flat, on which the site is located marks the drainage divide between Brown's Creek and Sevenmile Creek. The average elevation of this topographic flat is about 620 feet MSL. Sevenmile Creek occupies a valley due east of the site at an elevation of about 520 feet MSL. The ground distance from the site to Sevenmile Creek is about a mile and one half. Headwaters of Sevenmile Creek display an upstream steepening in profile at about 550 feet MSL, about the elevation where a majority of the springs draining the uplands are expected, since the headwater valleys broaden below this elevation. The U.S. Geological Survey Water Resources Bulletin of North Central Tennessee (page 134) reports that the majority of the springs draining the karst lowlands in the Nashville area occur in the Hermitage Formation. The upper contact of the Hermitage Formation with the overlying Bigby-Cannon Formation occurs at about 530 feet MSL along the northern bluffs bounding Sevenmile Creek.

Based on the above information, it is speculated that fracture controlled cave systems drain the uplands. The underground water then emerges at springs at or very close to the interformational contact.

Groundwaters draining from the site, to the west and north (into the Brown's Creek drainage), may not have the relief differential as outlined above. Brown's Creek is entirely floored by the Hermitage Formation. The large "sinkholes" noted on the geologic maps and located in the Bigby-Cannon Formation may, however, have drained into the Brown's Creek drainage because of their proximity to the valley; but it is suggested that the entire eastern part of the site has greater relief differential and hence the groundwater divide may, in fact, lie farther northwest of the surface topographic divide and maybe along the crest of the anticlinal flexure in Hermitage Formation (see Figure 2.3-6) immediately on the western margin of the site. This interpretation would result in groundwater draining preferentially to the east and southeast beneath the site.

2.5 POTENTIAL SOURCES

2.5.1 Source Characterization

The potential sources at the CSXT site have been divided into three categories. These categories relate the source's origin and potential behavior in the environment. The general location and geologic setting for each source is discussed. The characteristics common to the sources in each category, as well as any source specific concerns, will be addressed by the investigation discussed in Section 5.3, Subsurface Investigations.

A point source is considered a specific identifiable location where a leak or spill is suspected of occurring. A line source is a pipeline with potential leaks in multiple locations or a pipeline trench backfilled with permeable material capable of transporting contamination from one location to another (pipelines or their associated backfill). An area source is a non-point source of potential contamination whose exact extent is difficult to predict. Some potential sources may fall into multiple categories, such as an old point source which resulted in contamination of a line or area or multiple sources in a relatively small area. The location number from Figure 2.5-1 is provided where appropriate for each potential source.

It must be noted that the products which have been released to the subsurface are presently considered to be immiscible lighter than water fluids or light non-aqueous phase liquids (LNAPLs). The fluids may be expected therefore, to float on any water surface they encounter during gravity drainage from the original source. The subsequent movement of the floating product will then be governed by the physical processes which contains both the movement of water and the movement of the product itself.

Point Sources

A. Six Inch Diesel Fuel Line Rupture (Source #1).

B. Two Inch Diesel Fuel Line Rupture (Source #2).

C. Lube Oil Storage Tanks, Pumps, Loading and Unloading Area (Source #3).

D. Diesel Fuel Storage Tank, Main Fuel Pumps, and Main Fuel Filters (Source #6).

All these potential sources are located on the eastern third of the site in the vicinity of the roundhouse, oily wastewater treatment, and diesel fuel storage operations. The area is generally underlain by 5 to 40 feet of fill over bedrock, with the fill depth increasing to the south from the roundhouse area. Possible sink holes, in the northern portion of this area, have been noted on geologic maps and their locations roughly coincide with the topographic bedrock high which originally existed in this same vicinity (See Figure 2.4-3).

Line Sources

A. Two Inch Diesel Fuel Line (Source #2).

B. Six Inch Diesel Fuel Main Pipeline (which was formerly underground).

C. Storm Sewers (Fueling Station and Ready Tracks, Main Sewer Lines to Discharge Lift Station: Sources #4, 8, 9).

These potential fuel, lube oil, and yard drainage sources are also located primarily in the eastern portion of the site. The area has an extensive subsurface piping system for stormwater and wastewater drainage and for fuel oil handling (see Figure 2.5-1). These lines are suspected of having multiple leaks into the surrounding fill or trench backfill. The fuel line carries diesel fuel and the sewer lines carry wastewater contaminated with diesel fuel, lube oils, and yard drainage. The fuel oil lines primarily run north and south serving the operational areas on the eastern area of the site but in close proximity to the storm and wastewater lines, separated by fill or trench backfill.

Trenches dug for installing the stormwater and wastewater lines interconnect all the areas of the eastern portion of the site to the western portion via the trenches for the main storm drains, crossing the central portion of the site, to discharge the water to Brown's Creek (See Figure 2.5-1). Three stream valleys eroded into the western flank of the topographic high, speculated as running through the middle of the site (See Figure 2.5-1) provided the relief in the bedrock needed to allow gravity drainage in these drains.

Area Sources

1. Roundhouse Area (Source #5).
2. Fueling Station and Ready Tracks (Source #4).
3. Car Retarder Air Compressor and Oil Skimmer (Source #15).
4. Piggyback Crane Repair Area (Source #15).
5. Buried Retention Basin (Source #16).
6. Mill Building Drains (Source #17).

The Roundhouse area and Fueling Station and Ready Tracks are located in the eastern portion of the site. The geologic conditions in this area are similar to those described above for the point and line sources. These sources should consist primarily of fuel and lubricating oils and yard drainage contaminated with these oils.

The piggyback terminal area in the western side of the site encompasses several suspected potential sources. These include the previous oil skimming pond area immediately upstream from the discharge to Brown's Creek that was covered when the area was backfilled, the piggyback crane repair area, and the car retarder air compressor and oil skimmer.

The Mill Building drains are north and east of the roundhouse. This area is used for railcar repair and cleaning. The storm sewers serving the area have been inspected and appear to be plugged or collapsed, presenting a possible source of contaminants entering subsurface strata, fractures or natural drainage features.

2.6 POTENTIAL PATHWAYS

2.6.1 Subsurface Transport

Subsurface transport of contaminants and contaminated groundwater could be occurring through several natural mechanisms, all of which could be interconnected to each other or any of the manmade mechanisms discussed in the next section.

Flow in the fill will be influenced by several factors which include grain size, grain size distribution, compaction, layering, etc. The type of fill at the site varies from sand and cinders in the eastern portion of the site to blast rock mixed with excavated clay overburden throughout the remaining areas. The sand and cinder fill probably offers little resistance to flow and movement of oil and water through it, both vertically and horizontally. Within the blast rock (used to fill in the valleys on the west side of the site), infiltration may also be rapid. Movement in the finer grained soils (clays) may well be extremely limited. The amount and type of infiltration and recharge will influence the hydraulic movement of contaminants and groundwater. Infiltration rates to bedrock will depend on the type of material between the source and the bedrock. Sink holes are speculated to be located near the top of the bedrock topographic high in the vicinity of the sources on the eastern portion of the facility (see Figure 2.5-1). The presence of other hydraulic features connected within the fill, such as other sources and leaking storm sewers, will also influence the local movement, particularly in the eastern portion of the site. A flow divide is speculated to run along the western side of the site, roughly coinciding with the west flank of the bedrock high. Additionally, the presence of sinkholes and karst flow channels will influence the flow systems in the bedrock itself.

The flow in the fill in other areas of the site is influenced by the amount of clay overburden mixed with the blasted bedrock and the distribution of this type of fill with relation to the bedrock topography. Subsurface movement of fluids in this fill is probably slower than that expected for the type of fill encountered in the eastern portion of the site.

Varying thicknesses of clay overburden may be present over bedrock where the bedrock has not been excavated. Vertical movement into bedrock in these areas may be impeded by the clay. Flow would then follow the original topography and surface flow patterns. The geology map indicates that local drainage would tend to flow to the eroded stream valleys now occupied by the drainage piping and backfill.

After groundwater reaches bedrock, through normal area infiltration or through point recharge (sink holes), transport in the bedrock will be influenced by the karst features, which can be extremely unpredictable on a local basis. The predominant karst features capable of influencing flow beneath the site have been discussed, on a regional scale, in Section 2.3.

The concentration of contaminants in karst water systems may vary dramatically with time. Contaminants may be detected in karst water sampling locations long after a non-point contaminant source is discharged into the system. Sampling frequency must therefore be designed to delineate and adjust for such "maxima" that can be recorded long after the first pulse of the contaminant has been detected with the hydrograph peak. Because of conduit flow conditions and concentrated recharge, pollutant pulses move through the aquifer in long, time-separated, pulses because of conduit storage. These pulses can be driven by sudden storm/runoff events. The late arrivals are typically the "storm response" of karst conduit systems. The water that emerges, first from storage in a conduit system, is driven from behind by the storm pulse. The later stages of the pulse may be the actual storm maxima itself. It is thus imperative that any bedrock groundwater sampling strategy take these factors into consideration (for details see Quinlan J.F. and R.O. Ewers, 1985, "Groundwater Flow in Limestone Terrains: Strategy, Rationale, and Procedures for Reliable, Efficient Monitoring of Groundwater Quality in Karst Areas," in National Symposium and Exposition on Aquifer Restoration and Groundwater Monitoring; Proceedings of the 5th National Well Water Association Meeting, Worthington, Ohio; pp. 197-234).

2.6.2 Sewers and Structures

The line sources, located primarily in the eastern portion of the site, may be connected via the backfill of their installation trenches to the main deep drainage sewer system that is suspected of being capable of conducting contamination to the western portion of the site and thence discharging to Brown's Creek. These structures, and any trench backfill, may be hydraulically connected to surrounding conditions. The main drains conducting the wastewater to discharge from the eastern portion of the site are speculated as following the bedrock topography associated with backfilled original stream valleys. The depth of manholes for these drains is consistent with that expected from the original bedrock topography underlaying the area (See Figure 2.5-1).

Flow along the trenches will depend on the type of backfill but may be relatively rapid. In addition, any hydraulic connections to bedrock or other drainage patterns encountered by the trenches may intercept some of the flow. The mechanisms for discharge to the creek from either these structures, through bedrock, or fill are not identifiable at this time.

3.0 INTERIM CONTROL MEASURES

3.1 CONTROL AT KNOWN SOURCES

Special attention will be given over the next 6-month period to identify problems associated with the railroad servicing operations and minimizing the release of potential pollutants from the yard. This effort will be part of CSXT's ongoing program to improve "housekeeping" activities at Radnor Yard.

Efforts are being made to keep parked and idling locomotives awaiting assignment on tracks wit h track pans. Similar attention will be given to locomotive washing tasks. In this case, washing operations will be performed over track pans which drain to the emulsified oil wastewater treatment plant.

Periodic inspections of the track pans and cross drains in the fuelling and servicing areas will be made to ensure that the pans remain clean and functional. Repairs will be carried out on damaged track pans as they are identified. Accumulated sand will be removed from the pans on a regular basis. CSXT has completed a contract to clean sand from the track pan cross drains and sewers serving them; this can be repeated as necessary.

The automatic shut-off valves on the fuel lines in the fuel apron area will be maintained and repaired when necessary. Periodic inspections will also be made of the locomotive fuel tanks and filling spouts to ensure they are not leaking.

Employees will be encouraged to be more aware of fuel and oil spills that may occur and report such spills as specified in the site Spill Prevention, Control and Countermeasure Plan (SPCCP). Efforts will be made to recover spilled fuels and oils where possible. Particular attention will be given to the recovery of lost fuel in the turntable pit which presently drains to the main stormwater system.

New sources of petroleum products discovered during the course of the site investigation will be recovered if in the free product form. Heavily oil-contaminated soils may also be removed from the site for treatment and disposal.

3.2 MODIFICATIONS TO EXISTING SYSTEMS

Periodic checks will be made of the free-oil wastewater treatment system. A small amount of oil passes through the first stage treatment lagoon and accumulates in the northeastern corner of the final lagoon due to the prevailing wind direction. This oil can be lost from the system when the lagoon overflows to a ditch which drains to the site stormwater drainage system. The storage volume of the final lagoon will be maximized and overflows minimized by optimizing the pumped flow from the lagoon to the city sanitary sewer line.

Oils accumulating on the surface of the final lagoon will be removed in the interim period by the use of absorbent pads, or an oil-absorbing boom may be placed around the emergency overflow of the storage lagoon, along with an oil retaining boom, to prevent the loss of oil during high flow events.

how?

Floating oily wastes in the stormwater sewer will be more effectively separated and returned to the free-oil wastewater treatment system from the lift station located west of the car shop and east of the eastern-most classification yard tracks. It has become apparent that the effectiveness of this oil recovery unit is influenced by the amount of infiltration into the stormwater sewer system, as well as the location of the pump-operating-floats and the placement of skimming pipes and baffles. The design of the baffle and lift station will be inspected as part of this project. As-built drawings will be developed and the design reviewed. Simple changes will be implemented in the interim period, if appropriate, to improve the performance of this system to separate and remove oil contamination from stormwaters.

why are they waiting to do this

RESOURCE CONSULTANTS

A contractor presently pumps oil from the skimming manhole at this lift station, and hauls and then discharges it to the free-oil wastewater treatment system. The efficiency of this operation will also be reviewed for improvements. If a mechanism, or modified procedure, can be devised to make this operation more efficient, it will be implemented.

!

3.3 CONTROL AT DISCHARGE

Stormwater from CSXT's Radnor Yard property along with the flow in the East Fork of Brown's Creek emerges from a culvert downstream from CSXT property between some warehouses northwest of the intersection of Sidco and Powell. Oil booms have been placed near the discharge point to trap floating oil that has eluded the separation and collection facilities described above. The majority of the oil is absorbed by absorbent booms which are periodically replaced. A contractor also removes floating oil trapped behind the retention booms twice per week.

NO IT ISN'T!

The effectiveness of the oil booms to retain and absorb oil under varying stream flow conditions will be reviewed and improvements made as necessary. The effective life of the absorbent booms will be reviewed and the replacement of the booms on a more frequent basis will be recommended if necessary. Also, the contractor's oily water removal operation will be reviewed and modifications to either the equipment or the oily-water collection procedure will be implemented as necessary.

This is not enough. We already know that the booms are uneffective!

4.0 INVESTIGATION OF SITE DRAINAGE SYSTEMS

The Radnor Yard has a long history and the drainage systems that have been constructed over the years have resulted in a complex underground drainage network. Construction records for many of the older sewers do not exist and would be of limited value considering the many changes that have occurred over the years. The site drainage system can basically be divided into four categories: sanitary sewers, storm sewers, free oil sewers and emulsified oil sewers. Each of these systems is discussed in the following sections.

Some work concerning the water supply system is also envisioned. Water usage at the site is significant and the condition of the water lines is unknown. Leakages from this system could have a significant effect on groundwater levels and underground contaminant transport pathways. Some preliminary studies have been proposed to ascertain if water losses are significant and if further study is needed.

There are also numerous underground trenches which carry diesel fuel lines, lube oil lines, air lines and communication lines which could also effect site drainage pathways. The potential for the diesel and lube oil lines to contribute to underground petroleum releases has been addressed in Section 2.5.

4.1 SANITARY SEWER SYSTEM

Portions of this system are old and consist of a network of shallow sewer lines in the vicinity of the Roundhouse. RCI has already partially completed a significant amount of work under an existing contract in defining the locations and the linkages within this drainage network.

This work will continue during the site investigation study. Dye and smoke testing has been used to establish the relationships between some of the various sewer lines.

Physical inspections, along with additional testing, will eventually result in a site drainage plan which details all the existing active drainage lines.

4.2 STORM SEWER SYSTEM

Investigations of some of the smaller storm sewer lines have already been completed in conjunction with the sanitary sewer work described above. All known surface water collection points (for building downspouts, parking areas, etc.) have been located and mapped. Work will continue to establish the various connections to the remainder of the storm sewer network.

4.2.1 Main Storm Sewer - Upstream End

An investigation of the 36-inch diameter main storm sewer has already been authorized by CSXT. This investigation will be limited to the section of the sewer east (upstream) of the oil recovery lift station alongside the "bowl" to "hump tower" access road, and the 2 ft x 2 ft box culvert parallelling the tracks between the roundhouse and the car shop. The alignment of the 36-inch main storm sewer crosses beneath the engine house, locomotive service/waiting tracks and car shop area.

A three-man crew plus supervisor, with special safety, access and investigation equipment, will physically inspect a portion of this main storm sewer. The sewer will be entered at the only two available manholes (described above) and inspections will be made (conditions permitting) to distances up to 250 feet from a manhole. The condition and type of the pipe, conditions of joints, connecting sewers, holes and leaks, inflow and outflow areas, and any other unusual conditions found will be noted and reported. Photographs may be taken if conditions permit. Inflow streams may also be sampled and analyzed if conditions permit.

The execution of this work will obviously be dependent on weather conditions and the amount of infiltration into the sewer from groundwater. A completion goal of mid-October is projected at this time. A separate report and map will be prepared detailing the findings of this work. If summertime (dry) weather does not occur to allow the existing pump to dewater the sewer, then arrangements will be made for a specialty contractor to dewater the sewer.

4.2.2 Other Main Storm Sewers

Investigation of the upstream portion of the main sewer has been initiated because it is suspected that the location and condition of this line make it a more likely candidate for infiltration of oily wastewaters. However, similar work may also be required on other segments of this and other storm sewer lines at Radnor Yard.

There are four other main sewer lines on the site. They are as follows:

- Downstream Segment of Main Storm Sewer - This segment of line continues from the oil recovery lift station for approximately 1000 feet to the storm sewer junction manhole located on the western side of the site.

- Classification Yard Storm Sewer - This 48-inch line drains in a northwesterly direction to the storm sewer junction manhole, crossing under the classification yard. It is approximately 1600 feet long. There are no yard operations performed in this area that would routinely result in significant releases of petroleum products.

- East Fork Storm Sewer - This line conveys the flow northwards from the head of the East Fork and stormwater collected from the southern end of the Piggyback tracks via the ditches and retention basins on the western site boundary to the storm sewer junction manhole. Within this sewer's watershed is the piggyback crane repair area which recently received improvements to its oil containment capabilities. The East Fork storm sewer lies beneath the TOFC/COFC area and is approximately 1000 feet in length.

- Main Storm Sewer Discharge - This line carries all the stormwater collected in the lines described above from the storm sewer junction manhole to the discharge point which is northwest of Sidco Drive (beyond the site boundary). Much of this 48-inch line remains submerged at the discharge end. It is approximately 1200 feet long, and much of it is not on CSXT property.

Work will be programmed for these sewer lines according to findings and main sewer investigations. If it is determined that the backfilled trenches of these lines are conveying significant amounts of oily wastewaters, a program of further investigation and/or remediation will be developed.

4.2.3 Storm Sewer Conveying Drainage from Mill Building Area

A storm sewer serving the mill building, boiler house, car shops and work areas north-northeast of the roundhouse has been identified as a potential contaminant source, due to being plugged and/or collapsed in one or more locations. This storm sewer will be further investigated and repaired or replaced as conditions warrant.

4.3 FREE-OIL SEWER SYSTEM

These industrial sewers are located generally south of the roundhouse complex and serve the track pans on the ready (waiting) tracks and the track pans of the diesel locomotive repair shop. The sewers are designed to convey leaked or spilled petroleum products collected in the track pans to the free oil treatment facility. These sewers were installed in the early 1980s during the extensive renovation of the wastewater treatment facilities. The pipes, constructed of ductile iron and truss pipe, were laid under close supervision and good as-built drawings are available to locate these lines.

While these pipes could represent possible sources, there is little reason to suspect them as such at this point in the investigation. No special investigative work is directed toward this system at this time.

4.4 EMULSIFIED-OIL SEWER SYSTEM

This industrial sewer system carries emulsified oils from the locomotive washing, servicing, and repair areas to the emulsified-oil treatment facility at the site. As with the free-oil sewer system, this system has been installed relatively recently and it is considered unlikely that leakages from its location are significant. Again, no special investigative work is proposed for this system at this time.

4.5 TURNTABLE PIT DRAIN

This storm drain in the bottom of the turntable pit flows through a storm sewer connecting to an old, 2 ft x 2 ft box culvert, which in turn flows into the main 36-inch storm drain. Since the turntable pit is a potential source of oils and spilled diesel fuel, special attention will be given to this sewer connection. Remediation and corrective piping and pumping options will be explored.

4.6 OLD STORM SEWER PARALLELING ROUNDHOUSE WALL ON TURNTABLE SIDE OF ROUNDHOUSE

This old storm sewer was originally installed to collect drainage from roof downspouts on the roundhouse (which have long since been disconnected) and drainage from a number of the roundhouse pits (many of which have also been repiped to drain to a different sewer). Investigation of this old sewer system, and its associated pump installation (recently reinstalled to route the collected flow to treatment) will be part of the sewer investigation work.

4.7 WATER SUPPLY SYSTEM

A water balance for the site will also be performed, comparing the water usage for the whole site from water meter readings with the sum of estimates for water usage for the various individual operations that occur in the yard. While an accurate correlation is not expected, a large discrepancy between these two values could indicate loss of water through leaks in the water supply lines. Such leaks, if sizeable, could influence the hydrogeology of the site and be a contributing factor in the quantity of infiltration that appears to be occurring in the stormwater sewers.

If it appears likely that large water losses are occurring, additional measures will be recommended to isolate the location of the leak(s). Such measures may include the installation of water meters at strategic points at the site for continued, more accurate water estimates, or if the losses can be isolated to a particular area, detection of water leak locations by the use of hydrophones. As part of the work associated with the water lines, a project will be initiated to locate and map all of the known active water lines on the site.

5.0 INVESTIGATION OF THE EXTENT OF CONTAMINATION

5.1 NATURE OF POTENTIAL CONTAMINATION AND INVESTIGATION APPROACH

An understanding of the type and nature of potential contaminants is essential in the development of a site investigation plan. This information not only helps to determine which parameters should be tested for, but also provides guidelines which suggest where contaminants should be sought (for example, boring/coring/well locations and depths) and the type of samples that should be collected. Some background information is presented in this section on the potential pollutants at this site.

As described in Section 2, operations at the Radnor Yard are primarily locomotive servicing and repair, railcar servicing and repair, and railcar classification. Liquid contaminants that could be released to the environment from a facility such as Radnor Yard would in general be those that are associated with the repair and servicing operations. Those substances include diesel fuel, lubricant oils and greases, cleaning solutions, and engine cooling solutions.

The major substances of concern, therefore, are petroleum products which contain varying amounts of groups of component compounds. Diesel fuel is the most difficult substance to define, and is potentially the most mobile. Lubricant oils tend to be much heavier and more viscous than diesel fuel, and are potentially less mobile.

5.1.1 Components and Behavior of Diesel Fuel

Diesel fuel oils are rated into three grades (1-D, 2-D, and 4-D), generally based upon their volatilities and viscosities. The No. 1 grade is a more volatile class of diesel fuel with a lower viscosity, and the No. 4 consists of the more viscous distillates and blends with a lower volatility.

Diesel fuel characteristics are generally highly variable; however, the fuel can typically be divided into the following five compound classes and approximate composition:

- n-alkanes (degrade somewhat rapidly) —37.6% of fresh diesel oil
- iso- and cyclo-alkanes (degrade somewhat slowly) —37.6%
- isoprenoids (e.g., pristane and phytane, highly branched iso-alkanes very resistant to degradation) —3.5%
- aromatics (water-soluble hydrocarbons, predominated by parent and alkylated benzenes, toluenes, xylenes, napthalenes, hydrindenes, phenanthrenes, and fluorenes) —20.2%
- polars (water-soluble sulfur, nitrogen, and oxygen compounds) —1.1%

When diesel fuel is spilled into the uncontrolled environment, the partitioning of the various components and the physical, chemical, and biochemical processes at work in the environment can dramatically change the composition of the fuel mixture. Understanding the partitioning in a spill situation will assist toward selecting appropriate investigative techniques and effective remedial responses.

5.1.2 Sampling Methodology

Two basic groups of information are required to assess the vertical and horizontal extent of contamination at any site. First, the presence of contaminants at various depths (whether it be in free product form or dissolved) and second, basic information must be established on the site soil types and characteristics at various depths, the depth to the uppermost aquifer (groundwater table), and the various characteristics of the aquifer.

A variety of different analytical tests may be used to detect the presence of diesel fuel contamination and to trace the progress of fuel which may be migrating underground. The more common tests involve "oil and grease" testing or "petroleum hydrocarbon" testing. Testing for specific volatile or semivolatile organic chemicals can also be performed using gas chromatography (GC), or all possible compounds can be detected using the GC along with mass spectrometry (GC/MS). Detection limits, quantitation limits, costs and turnaround times are all important considerations when developing a sampling program.

The following parameters are potential indicators of contamination which will be used selectively in assessing the Radnor Yard site:

- TRPH (Total Recoverable Petroleum Hydrocarbons) - This is perhaps the best available test for quantifying petroleum hydrocarbons; however, the procedure may loose highly volatile fractions during the extraction and polar hydrocarbons (such as complex aromatics and sulfur, nitrogen and chlorine containing organics) during the silica gel adsorption step. It can be run by several different methods, each of which has advantages and disadvantages.

- BTEX (Benzene, Toluene, Ethylbenzene and Xylene) - These compounds are commonly used to qualitatively indicate the presence of volatile hydrocarbons. The test involves the use of a gas chromatograph (GC).

- Selected Organics by GC/MS - Limited GC/MS scans will be run on some of the samples collected to determine the types of compounds that are present.

- Selected Organics by GC - Organics identified in the GC/MS analyses will be selectively analyzed for if warranted.

- Phenols.

- PCBs (to verify absence).

- Metals - Lead, copper, zinc, nickel, chromium, cadmium, and boron (which is used in engine coolant solutions).

The planned site investigation has been divided into two phases; a surface investigation and a subsurface investigation. The surface investigation will delineate existing areas of contamination on the site, determine the probable cause and determine if the problem is surficial or a potential source of groundwater/surface water contamination. More details are presented in Section 5.2.

Characterizing the site subsurface conditions and extent of contamination usually involves geotechnical exploration and testing, with soil borings, coring and the very selective installation of monitoring wells with the concurrent logging and sampling of materials removed from the well bores. Methods used for underground exploration and testing are generally controlled by soil and rock conditions existing at the site along with the depth to which the investigation is being conducted. The methods proposed for the subsurface investigation at this site are described in Section 5.3.

5.2 SURFACE INVESTIGATION

The entire Radnor Yard site will be surveyed and areas that are contaminated by oil or other petroleum products will be noted and located on a site plan. Ground materials will be examined to determine if the material is saturated (i.e., free product is present). The ground will be penetrated to a depth of several feet, if possible, to determine if vertical migration of the substance has occurred. Some samples can be collected to determine the identity and extent of contamination, if necessary. Concrete containment areas will be checked for cracks and drainage pathways that could result in the release of these compounds to the environment.

Particular attention will be given to the areas impacted by known fuel line leaks or releases. For example, the 2-inch fuel line near the turntable will be investigated. Other areas include the load test area, the turntable pit, and the locomotive ready tracks (waiting areas).

Railroad operations at the yard will be reviewed in detail to establish the potential for oil or other petroleum releases. The review will include interviews with CSXT workers who will be able to describe the normal operating procedures and perhaps historical practices at the site. Additional track pans may be recommended if a need for such is apparent.

The condition of the track pans and cross drains will be reviewed in detail. Attention will be given to ensure that these units are not clogged with sand and that they function properly.

5.3 SUBSURFACE INVESTIGATIONS

5.3.1 Geologic Mapping

The Subsurface conditions at the site are considered to be both complex and difficult to investigate. Consequently, a thorough investigation of the regional bedrock will be conducted to characterize any mechanisms, on a regional basis, which may be capable of influencing site hydrologic conditions. This investigation will include a review and interpretation of available aerial photography (including pre-1982 photographs) and field mapping of all outcrops in the vicinity of the site to define fracture orientation aperture and spacing. All streams and springs, where possible, will be located in the field to verify their relationship to the site stratigraphy and determine their elevations. This information will lead to an improved definition of the hydrogeologic conditions and the position of the drainage divide which lies between the Sevenmile and Brown's Creek drainage basins.

5.3.2 Geophysical Exploration Methods

Due to the presence of clays and metals (i.e., rails, piping, etc.), the use of geophysical methods to define subsurface conditions has been all but ruled out. The reviewed and rejected geophysical techniques include:

- Gravity - not sensitive enough, too much vibration.
- Seismic (Reflection and Refraction) - site is too noisy.
- Electromagnetic - too much interference - low sensitivity.
- Magnetics - too much interference - low sensitivity.
- Ground Penetrating Radar - clay soils preclude good penetration.
- Cross borehole Radar - possible in bedrock.

The decision to attempt borehole radar would be taken if conditions indicate its use is warranted and sensible results may be obtained.

5.3.3 Drilling Investigations

5.3.3.1 Soil Borings

Prior to completing any borings, continued review of available data will be used to refine or redefine the positioning of the proposed set of probe holes. This review will utilize the existing boring records and any information available from the surface investigation.

In general, borings will be located to:

- Determine the nature of materials and subsurface topographies adjacent to potential sources.
- Investigate the presence of contaminants adjacent to potential source.

This set of borings is not designed to function as a final monitoring well network. It must be realized that an adequate long term monitoring system should be designed when the hydrogeology of a site and the disposition of contaminants is understood. Furthermore, the complexity of flow in karst bedrock may result in monitoring wells being ineffective for determining ground water conditions.

Depending on conditions, holes will be completed as piezometers if groundwater/fluids are encountered. Drilling will be completed in phases with the results of a preceding phase being utilized by the succeeding phases.

Sixteen areas are identified on Figures 2.5-1 and 5.3-1 as potential sources at the CSXT Radnor Rail Yard. Boring locations adjacent to the sources have been selected primarily on the basis of geologic data gaps. Fourteen borings are outlined in Figure 5.3-1.

These locations are approximate, the actual locations will be governed by field conditions, access, etc.

Six shallow borings will be advanced into the fill to depths of approximately 20 to 30 feet to sample the overburden. The actual depth will be determined by field conditions. In some cases, the borings may encounter bedrock at shallow depths. These borings will then be cored (5 to 10 feet) to prove that the bedrock basement has been reached. The remaining eight deep borings will be advanced to top of bedrock and then cored to verify the bedrock basement. These holes will provide additional data on the bedrock topography, the clay/bedrock interface, and the nature of material backfilling sewer trenches.

Logs of previous borings indicate that the depth and type of fill varies significantly across the site. The borings will be advanced using hollow stem augers and sampled continuously using a 2-inch split spoon sampler where possible. Should subsurface conditions prevent the use of hollow stem augering, other methods, such as Odex or OD methods (See Appendix A), will be used to advance the boring. A qualified field geologist shall provide supervision of all drilling procedures and log all soil and rock samples in accordance with the specifications provided in Appendix A. All cuttings and fluids removed from the borehole during drilling will be contained for later disposition (to be determined) by CSXT. The borings will then be abandoned according to the procedures in Appendix A. All drill work will be conducted according to the Safety and Health Plan prepared specifically for this project. This Plan has been included as Appendix B.

At this stage of the investigation, it is not considered warranted to complete the borings with stainless steel well screen and riser pipes. In the initial series of holes, PVC well screens will be utilized to obtain data regarding groundwater levels, the existence of contaminants, etc., where appropriate.

Subsequent to better definition of the contaminant conditions, a long term monitoring well network with specifically located monitoring wells, if appropriate, will be installed to monitor the improvement of conditions due to remediation.

If during drilling, free product (diesel oil) is encountered, a decision will then be made to either pump the product using the boring or a specifically designed extraction well will be installed.

5.3.3.2 Piezometer Installations

In addition to the soil borings, the locations of three piezometer clusters are identified on Figure 5.2-1. These holes will be used to better define the hydrogeologic characteristics of the overburden and bedrock. One piezometer at each location will be completed in the overburden and one at the overburden/bedrock interface if groundwater is encountered. One NX sized corehole will be completed as a piezometer in the shallowest (uppermost) saturated bedrock aquifer. The overburden piezometers will not be installed if groundwater is not encountered. This system of piezometer clusters will allow for the isolation of shallow saturated zones during the boring and installation of subsequent deeper piezometers, and will result in piezometers being installed only where groundwater is encountered.

This protocol will result in three piezometers being installed in the shallowest bedrock aquifer. These piezometers will be constructed of 2-inch PVC screen and riser pipe completed according to the specifications in Appendix A. For the bedrock piezometers, a permanent steel casing will be set through the fill and unconsolidated overburden when bedrock is reached. The bedrock will then be continuously cored until the bedrock aquifer is encountered. The rock core will be photographed and logged in detail by the field geologist using the International Society of Rock Mechanics (ISRM) system. Particular attention will be paid to the bedrock weathering conditions and the number and type of fractures.

5.3.4 Soil and Groundwater Sampling

Soil and groundwater samples will be collected from each borehole for analysis of the contaminants potentially representative of the site's sources. The total number and type will be determined in the field but at minimum should include one soil and one groundwater sample per boring.

Groundwater levels or pressures will be monitored using electronic water level finders. The effects of floating product on the groundwater levels will be compensated for and the thickness of floating product calculated from the thickness of product measured in the piezometers.

Total petroleum hydrocarbons (TPH) or total recoverable petroleum hydrocarbons (TRPH) will be used as the primary analytical test for determining or tracing oil contamination. The exact test methodology used will be dependent on sample matrix (i.e, soil, water, sludge) and upon the detection limits/quantitation limits desired. It is anticipated that gravimetric, infrared (IR), and GC methods may all be employed as appropriate. Some GC/MS scans may be run for organics, as well as some GC scans for specific organics. Some inorganic analyses and other parameters may also be made part of the sampling and analytical program, depending upon the results obtained in the initial phases of surface/source analyses. Refer to Section 5.1.2.

5.3.4.1 <u>In-Situ Testing</u>

In-situ permeability tests will be conducted on representative sections of saturated fill or overburden horizons. These tests will either be rising or falling head tests with variations in the groundwater level being tracked with a transducer and data logger. The soil cuttings will be classified in the field (using USCS classifications) with grain size analyses on appropriate samples, being completed in the Laboratory using ASTM D422 methods.

Other tests have been considered, but insufficient information exists at this time to adequately design a plan which utilizes them. Dye tracer testing is appropriate for evaluating the flow system in bedrock, however, the design of such an investigation would rely on the results of the investigation outlined in this plan. These procedures should be reconsidered as the investigation proceeds and more appropriate conditions for their use are identified.

5.3.5 Surface Water Investigation

As noted in the discussion of the regional geology, a potential exists for some hydraulic connection between the site surface and subsurface sources to a regionally significant bedrock groundwater flow system which typically has multiple surface discharge points (springs). These connections are often complex, therefore not all of the site's impact may be limited to Brown's Creek. Delineating the relationship of the karst feature to the site may not be necessary to characterize the site's impact on Brown's Creek, however, a surface water investigation of all discharge points (springs) surrounding the site may be necessary to understand this mechanism at a local area level.

6.0 DEVELOPMENT OF FINAL REMEDIAL MEASURES

6.1 ALTERNATIVES FOR CORRECTING EXISTING CONTAMINATION

The findings of the site investigation will determine the presence, or absence, of petroleum products that may be contaminating the stormwater and/or groundwater emanating from the Radnor Yard site. In addition, attempts will be made to characterize these substances if such materials are found. This information, along with details of the site's geologic structure and hydrogeological characteristics are required before appropriate remedial alternatives can be selected.

It is difficult, therefore, to define at this time which particular remedial methods may later be used; however, a remedial strategy has been developed and is outlined below. Examples of remedial options that may be considered for this site have also been included.

1. Actions will be taken to stop the continuing release of products that can be directly attributed to active and on-going operations at Radnor Yard. For example, pipelines or tanks that are found to be leaking will be repaired or removed from service until repairs can be arranged.

2. If sufficient free product has accumulated underground in a pool, floating on top of the groundwater table, then the free product would be removed as soon as possible in order to minimize the spread of contamination. The method for removing free product depends upon the location of the material, site topography, geology, hydrology (hydrogeology), and other considerations, including accessibility. This material will be recovered as soon as an appropriate recovery system can be installed.

3. If extensive areas of contamination are found in areas that are subject to contaminant transport via groundwater movement, methods of containing the contaminated groundwater will be evaluated for stopping the migration of contaminants from the Radnor Yard site. Options include the construction of a physical barrier, such as a slurry wall, or creating hydraulic divides by modifying the groundwater profiles on site. These methods would be a major undertaking and require additional studies, and are beyond the scope of the activities included in this Corrective Action Plan.

4. Correction of heavy contamination of soils by petroleum products will be evaluated during the course of this project. Specifically, the applicability and performance of biological remediation to reduce petroleum concentrations will be evaluated. Alternative remedial actions such as modifying the mobility of these substances will also be studied. Information will also be collected so that preliminary costs can be developed for the removal of heavily contaminated soil materials to a proper disposal site or other forms of treatment.

On-site alternatives for remediation are much preferred due to the costs involved. The success of bioremediation methods for the treatment of petroleum product contamination at other sites in the US is particularly encouraging.

Briefly, bioremediation involves the enhancement of natural conditions so that bacteria which are naturally occurring at the sites can propagate using the petroleum products as an energy source (food). Enhancement of the environment includes ensuring oxygen and adequate nutrients (nitrogen, phosphorus and other micronutrients) are available to the bacteria. Some surfactants and emulsifiers will probably also be required to dissolve heavier petroleum fractions.

Bioremediation is seen as being particularly appropriate for areas of surface, or near-surface, contamination where oxygen is available from the air and nutrient additions can be easily applied and the response monitored. The use of biological treatment for subsurface remediation may be less suitable for this site, particularly if the subsurface transport mechanisms are found to be highly dependent on the karst geology. Groundwater flows in this case could be highly channelized and irregular.

Samples of petroleum-contaminated soils/ground materials will be characterized and subjected to treatability tests in the RCI laboratory. The treatability studies will be used to screen various nutrient levels and test surfactants on samples collected from particular areas of the site. The best performing combinations of nutrients and surfactants will then be tested at the site on a pilot scale to refine the application procedures for actual site conditions.

Any bioremediation activities should be considered as a long-term program. Areas where bioremediation appears suitable and the development of suitable procedures for implementing such a program should be well-developed by the end of the project; however, the application of an entire site treatment program will extend beyond the 28-month period of actions defined in the Agreed Order.

Other methods of remediation, such as incineration or soil washing with surfactants will be considered as circumstances may warrant.

6.2 PREVENTION OF FUTURE POLLUTANT RELEASES

The primary goal of this project is to identify, and correct, areas of released petroleum products that may exist on the Radnor Yard site which may be causing contamination of the East Fork of Brown's Creek or the migrating groundwaters beneath the site. CSXT is committed to achieving this goal and ensuring that problems of this nature do not continue.

Yard operations will be reviewed, as noted in previous sections, and areas sought where improvements can be made in the daily operating procedures to stop any future releases of petroleum products. These efforts, in association with the removal, containment, and remediation of potential petroleum-contaminated areas on the site, should minimize the recurrence of petroleum product contamination of the stormwater in Brown's Creek.

Modifications to the existing oil collection and treatment facilities on site may be possible. Renovation of existing stormwater system to minimize infiltration may also reduce the problem.

It is believed that this study will improve management and worker awareness of this problem and that the ability to respond to future petroleum product leaks or releases will improve.

Recommendations for a long-term site monitoring program will be presented to CSXT as part of the environmental control program.

7.0 IMPLEMENTATION OF CAP AND REMEDIAL ACTION ELEMENTS

The Agreed Final Order stipulates the following milestones which are to be completed within prescribed periods:

1. Implementation of the CAP, including the initiation of any required interim remedial measures, is required within thirty (30) days following receipt of written approval of the plan, or the issuance of any required permit(s), whichever occurs later. not NPDES

2. CSXT is to complete the work outlined in the CAP, including all necessary construction, and be in full compliance with the Tennessee Water Quality Control Act, within twenty-eight (28) months following initial implementation of the Plan. This does not include, however, any required long-term soil or groundwater treatment and monitoring.

3. Quarterly progress reports are to be furnished to the Division commencing the first full quarter following initial implementation of the approved CAP. These reports will be due prior to the fifteenth day of September, December, March and June.

In order to meet the deadlines established in the Order, a schedule has been developed and is presented as Figure 7.0-1. A phased approach will be necessary to complete the various comprehensive investigations described in this plan within the allowed time-frame. It is anticipated that this plan will need to remain flexible and capable of responding to changes that will occur as more information on the site becomes available via the ongoing site investigation activities.

Activities will proceed as time permits, with special priority being assigned to tasks that require completion during seasonal weather conditions. The quarterly progress reports will be used to keep the Division informed both of progress achieved in the last quarter as well as work that is programmed for the following quarter.

Remedial actions that can be implemented easily will be pursued as soon as possible. Long-term actions may require further study, depending on the extent of any particular problem which is discovered.

CSXT is committed to implementing the CAP and to implementing the appropriate remedial actions, as well as the necessary construction of new or revised collection and treatment facilities within the time frames outlined in the Agreed Final Order.

8.0 INTERIM MONITORING PLAN

8.1 SCOPE

An interim sampling program will be implemented during this project. Sampling will include both surface waters and groundwater.

8.1.1 Surface Water Sampling

Five surface locations have been selected for interim sampling. They are as follows:

1. Brown's Creek upstream from the Yard at the entrance of the culvert exiting the stormwater retention pond. — ?

2. Brown's Creek downstream from the Yard at the first riffle immediately downstream from the oil booms (about 20 feet downstream from the mouth of the culvert).

3. The downstream end of the roundhouse area storm sewer at the 50-foot deep manhole on west side of TOFC yard behind temporary office trailers. The sample is to be collected approximately 3 feet up the sewer barrel from the manhole.

4. The downstream end of the storm sewer crossing the classification yard in a northwesterly direction at the 50-foot deep manhole. The sample is to be collected approximately 3 feet up the sewer barrel from the manhole.

5. Also within the 50-foot deep manhole, the downstream end of the East Fork Brown's Creek storm sewer which enters the 50-foot deep manhole from the

south, carrying the TOFC/COFC yard runoff. The sample is to be collected approximately 3 feet up the sewer barrel from the manhole.

8.1.2 Groundwater Sampling

Samples will also be collected from the two existing monitoring wells on the site. The well locations are adjacent to the diesel storage tank and adjacent to the lube oil storage/pumping area.

Additional bores will be made and wells may be installed over the duration of this project and sampled as part of the subsurface investigation phase of the project. These locations can also be incorporated into the interim monitoring program if it is shown that the information generated from such wells would be useful.

8.2 MONITORING PARAMETERS

It is proposed that the surface waters will be tested monthly for the following parameters:

- Total recoverable petroleum hydrocarbons (TRPH)
- Total suspended solids (TSS)
- Hydrogen ion concentration (pH)
- Chemical oxygen demand (COD)
- Biochemical oxygen demand (BOD)
- Total organic carbon (TOC)
- Methyl blue active substances (MBAS)
- Phenols
- Boron

Groundwater samples will also be analyzed monthly for the following parameters:

- TRPH
- Polychlorinated biphenyls (PCB)
- Benzene, toluene, ethylbenzene and xylene (BTEX)
- Boron
- Heavy metals (Pb, Cu, Ni, Zn, Cr, Cd)

In addition to the above analyses, organic compound scans by a gas chromatograph/mass spectrophotometer (GC/MS) will be performed one time on an oil sample (if any is present) and one time on a water sample from each of the existing monitoring wells.

8.3 REPORTING

It is intended that this interim sampling program will continue for a five-month period. Analytical results can be included in the quarterly progress reports as they become available.

At the end of this period the findings will be reviewed and a decision made whether to continue with the sampling program as described above or in some modified form.

9.0 SAFETY AND HEALTH PLAN

A Project Safety and Health Plan has been prepared for the proposed work at the Radnor Yard site. A draft of this Plan is presented as Appendix B. The Safety and Health Plan will be finalized after the scope of the Corrective Action Plan has been finalized and a start date for site work has been agreed.

10.0 QUALITY ASSURANCE/QUALITY CONTROL PLAN

10.1 ANALYTICAL LABORATORIES

The laboratory analyses for samples collected during this project will be conducted by the Resource Consultants, Inc. laboratory. The laboratory has been serving RCI engineers and its own client base since 1971. The laboratory specializes in standard, wet chemistry, environmental tests, metals, PCBs, solvents, waste characterization analyses and wastewater treatability studies. It is also presently involved in solid waste, indoor air, industrial hygiene and asbestos consulting. A new organics lab will be able to analyze volatile organics in water and soil using purge-and-trap, FID, PID and Hall detectors.

The laboratory is certified in all states where certification procedures are available. This includes the State of Tennessee. It is also certified by the Metropolitan Government (Metro) Nashville for wastewater and hazardous waste analysis. The laboratory is officially approved in Indiana and Illinois where there are presently no certifications. The laboratory also participates in EPA's NPDES quality assurance program and in the American Industrial Hygiene Association's Proficiency Analytical Testing Program.

RCI has a great deal of experience with wastewaters and wastes generated by railroad operations. In particular, RCI has the capability of running the so-called "California Method" for Total Petroleum Hydrocarbons, as well as running several other TPH/TRPH methods which may be appropriate for this analytical program.

As the RCI laboratory does no yet have gas chromatograph/mass spectrophotometer (GC/MS) capabilities, GC/MS samples will be analyzed by another commercial laboratory in Nashville.

10.2 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

All laboratory quality assurance and quality control objectives will follow the guidance contained in the Quality Assurance Plan of Resource Consultants, Inc, which has been attached as Appendix C. A brief summary has been included below of the typical procedures that will be used to assure quality control of work performed in the laboratory.

- Reference standards will be run at a 10 percent frequency.

- Sample duplicates will be performed on 10 percent of the samples.

- Sample spikes will be run at a 5 percent frequency except for the metals analyses performed on the graphite furnace atomic adsorption spectrophotometer where all samples are spiked.

- One reagent blank will be run with each batch of samples.

The principal criteria used to validate data are:

- inspection of the calibration curve from past data to ensure that sensitivity and linearity are comparable.

- inspection of reference standards to determine if they are in control or if recalibration was performed when needed.

- batch sample blanks are not more than two times the detection limit.

- spike and duplicate samples are within the control limits.

- unusual results for a given sample source are rechecked.

- selected calculations and dilution factors are reviewed. If data is not validated, then the senior chemist will examine the analysis for that particular parameter and invalid data will be rerun, starting from the original sample, if possible. If a reanalysis is not possible, and/or a systems check on the analyte cannot discover the error, the sample data is invalidated.

10.3 DATA MANAGEMENT AND REPORTING PROCEDURES

10.3.1 Field Data

Information on samples collected during this project will be handled consistently to ensure that all data is available for later evaluation. The following procedures will be used for management of the sample and laboratory data.

Field investigation personnel will collect the samples for analysis. Samples will be labelled and sealed. Sample information is written on the label and entered onto the Chain of Custody sheets. Copies of these records are retained in the project file, by the client (if requested) and are included in the completed laboratory report.

1. Project title, location and number.
2. The sample location identifier.
3. Laboratory log number (assigned on arrival at lab).
4. Sample container type and preservative (if any) used.
5. Sample collection date and time.
6. Sample description and remarks.

All samples will be logged on arrival at the laboratory. The Project Engineer or Project Manager will advise the laboratory on which analyses should be performed on each sample, based on the results of previous sample results. Although all samples may not be tested, all will be held in storage until the project's completion.

In addition to the sampling information, a field log book will be maintained on site, during sampling activities, which will record all activities that occur during the sampling investigation. Information that will be kept includes the following:

1. List of people on site
2. Name of sampler(s)
3. Dates & times of sampling activities
4. Field observations
5. Contractor hours
6. Safety information

10.3.2 Laboratory Data

On arrival at the laboratory, the condition of the samples will be checked and split into aliquots and preserved as necessary. Samples will then be logged onto the Laboratory Information Management System (LIMS) developed by RCI and automatically assigned a unique sequential laboratory log number. The pertinent analytical tests will also be requested at this time. After logging in, the samples are stored by the laboratory code in ambient-temperature or cooler storage areas, whichever is appropriate. Samples will be tested within the required hold-times and archived.

The RCI LIMS system, or "Lab Companion", is used to log-in samples, generate worksheets, enter data, retrieve collated data, approve results, check sample status, and generate reports, invoices and archives. Chemists performing the analyses complete the computer generated worksheets for each test. Each worksheet contains all the information necessary to calculate the test result. The worksheets are maintained in workbooks (one book per test method) which are checked and approved by the Lab Manager or Supervisor before the information is entered into the computer system by a data entry specialist.

The laboratory has an assigned Quality Assurance Manager who maintains the data required under the laboratory Quality Assurance/Quality Control Plan. More information on the procedures for flagging samples which fail QA/QC checks and the Quality Assurance Manager's duties can be found in the QA/QC Plan.

The Lab Manager then reviews and checks all tests performed on a particular sample to ensure all the required analyses have been performed and the consistency is maintained in the results. Finally, the file is sent to the Laboratory Director for final review and report generation. Computer records are then archived but remain accessible.

Results from the laboratory are transferred to a database or electronic spreadsheet for evaluation and inclusion in the project report.

10.3.3 Data Reduction

Primary considerations in data reduction will include the treatment of replicates, outliers and values which are less than the detection limit. Replicate measurements will be made on at least one in every 10 samples, as stipulated in the QA/QC Plan. Replicate measurements will be averaged prior to further data reduction to remove any bias on the overall mean.

Outliers may occur as a result of inconsistent sampling or analytical chemistry methodology, errors in transcription of data values and extreme concentration measurements. Raw data will be screened for apparent discrepancies and checked to ensure they represent valid measurements. Once procedural methods and calculations have been corrected (if necessary), the data will be included in the project data set and reported. Single outlier values may not necessarily be used in calculations if it is demonstrated that they lie beyond the 95th percentile value of the remainder of the data set.

Concentrations that are below the detectable limit for the method used will be reported as "BDL". The value of the detectable limit will be used in subsequent calculations when necessary.

10.3.4 Reporting

Laboratory data will be presented in tabular formats using an electronic spreadsheet or database report. In addition, data may be presented graphically on maps or other diagrams to show spatial trends in concentrations where appropriate.

APPENDIX A

ODEX DRILLING SYSTEM

APPENDIX

ODEX DRILLING SYSTEM

(TAKEN FROM ATLAS COMPCO MANUAL)

(FORTH EDITION)

JOB NO.	903-6309	SCALE	N.T.S.	
DRAWN	JSG	DATE	07/09/90	
CHECKED		DWG. NO.		
Golder Associates				CSX TRANSPORTATION INC. / FIGURE

152978

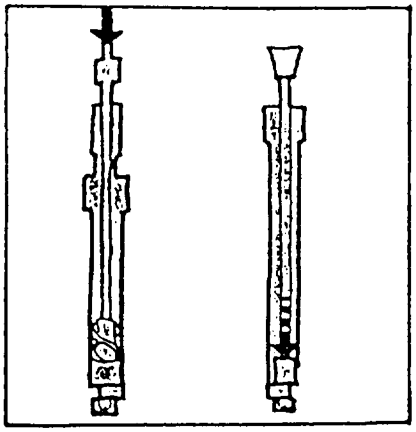

Fig. 19:32 Percussive drilling

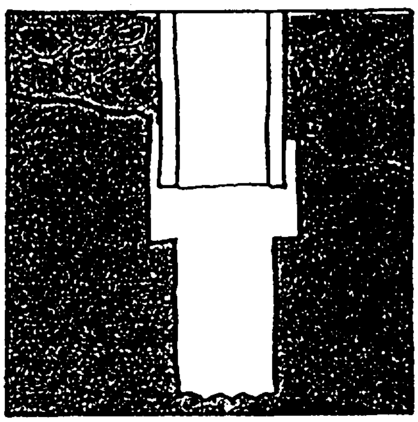

Fig. 19:33 Lining

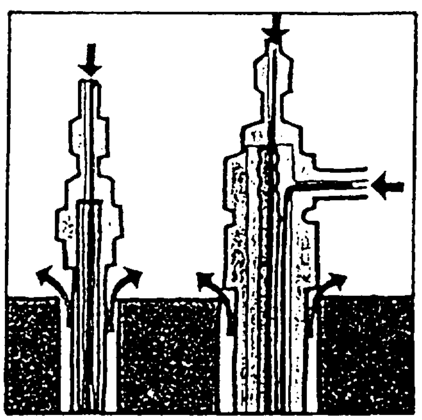

Fig. 19:34 Flushing

19.8.2 The Odex method

Principle

The Odex method is based on the principle of under-reaming. The eccentric bit makes it possible to insert casing tubes into a hole at the same time as the hole is being drilled. During drilling the reamer on the Odex bit swings out and drills a hole larger than the outer diameter of the casing tube (19:35). When the desired depth has been reached the equipment is rotated a couple of revolutions in the opposite direction, whereupon the reamer is folded in and enables the inner equipment to be retracted through the lining, which remains in the hole. If drilling is to be continued in solid rock, the Odex bit is replaced by an ordinary drill bit and drilling proceeds through the lining with extension equipment or with down-the-hole equipment. In prospecting operations, drilling is sometimes continued with diamond drilling equipment.

Odex is available both for top hammers and for down-the-hole drills of types COP 42, COP 62 and others. When drilling with top hammers a high-torque drill, such as a BBE 57 or a BBE 53, must be used.

JOB NO. 903-6319	SCALE N.T.S.	
DRAWN EAM	DATE 07/09/90	
CHECKED	DWG. NO.	
Golder Associates	CSX TRANSPORTATION INC.	FIGURE

152978

Lining

Either threaded pipes or weldable pipes of an ordinary commercial grade of steel are used as the lining. When the pipes are left in the hole, e g in water-well drilling, welded pipes are customarily used. Threaded pipes are used for such applications as blast hole drilling, anchoring and stabilizing, when the pipes will be withdrawn from the hole and used again. When the pipes are to be pulled out, the driving cap and adapter sleeve, if any, are replaced by a pipe lifter.

Flushing

In top hammer drilling, the flushing medium is supplied to the drill string through a flushing head. In down-the-hole drilling, the flushing medium is supplied centrally through the rotation unit and drill rods. The cuttings and sludge make their way into the space between the inner equipment and the lining and are removed through a pipe on the driving cap.

The cuttings are screened in the space between the guide and the lining. Coarse particles, which are too heavy to be carried by the flushing medium, go back for recrushing.

In holes up to about 20 metres in depth, air is usually employed as a flushing medium, but water can also be used.

If flushing is to be effective in holes more than 20 metres deep, flushing with foam is recommended. The foam is formed by adding to the flushing air both a lubricant and a mixture of water and biologically degradeable tensides. The foam mixture carries the cuttings effectively. The foam also serves to stabilize and lubricate the walls of the hole, making it easier for the lining to slide down. It has also been found that foam flushing reduces wear on drilling equipment.

When Odex equipment is used for grouting, the cement is injected through the lining, which is withdrawn successively as the grouting proceeds. The cement is pumped in through a special injection sleeve, which is fitted in place of the driving cap and adapter sleeve, if any.

When to use Odex

The Odex method is useful when one or more of the following difficulties are encountered:

- poor hole-wall stability, which calls for the use of casing tubes
- stony soil
- poor rock.

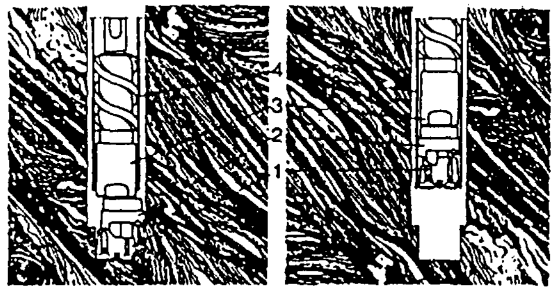

Fig. 19:35 Principle of the Odex method
To the left drilling
To the right removal of the drilling equipment
1. pilot bit
2. reamer
3. guide
4. casing tube

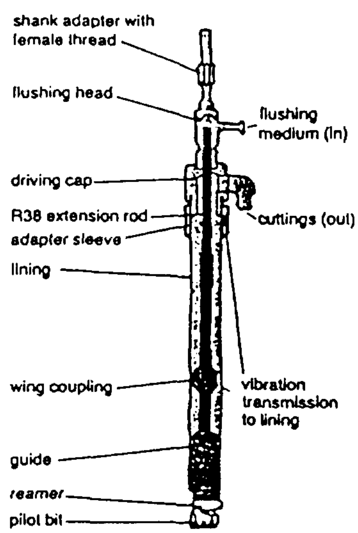

Fig. 19:36 Odex for top hammer

JOB NO. 903-6319	SCALE N.T.S.			
DRAWN EAM	DATE 07/09/90			
CHECKED	DWG. NO.			
Golder Associates		CSX TRANSPORTATION INC.	FIGURE	

152978

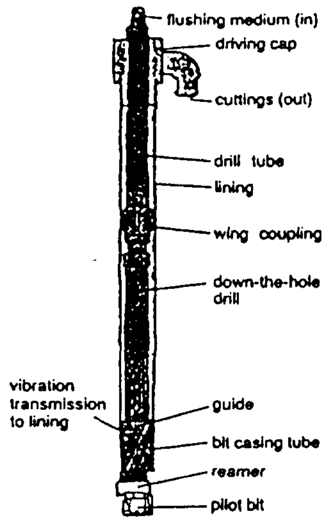

Fig. 19:37 Odex for down-the-hole drilling

Important features of the Odex method

The method offers evident advantages. However, care must be taken in planning the use of the Odex method. Drilling will probably be unsuccessful if attention is not paid to the following points:

- correct choice of casing tubes (inner and outer diameter and length)
- welding (when smooth casing tubes are used)
- flushing: correct choice of flushing agent for the drilling in question
- drilling methodology.

19.8.3 The OD method

The OD drilling equipment (19:38) consists basically of an outer casing tube with a ring of cemented carbide at the lower end. The casing tube encloses an inner drill string made up of standard drill steels with a cross bit. The casing tubes and the inner drill steels are of the same length and are jointed by couplings sleeves independently of one another.

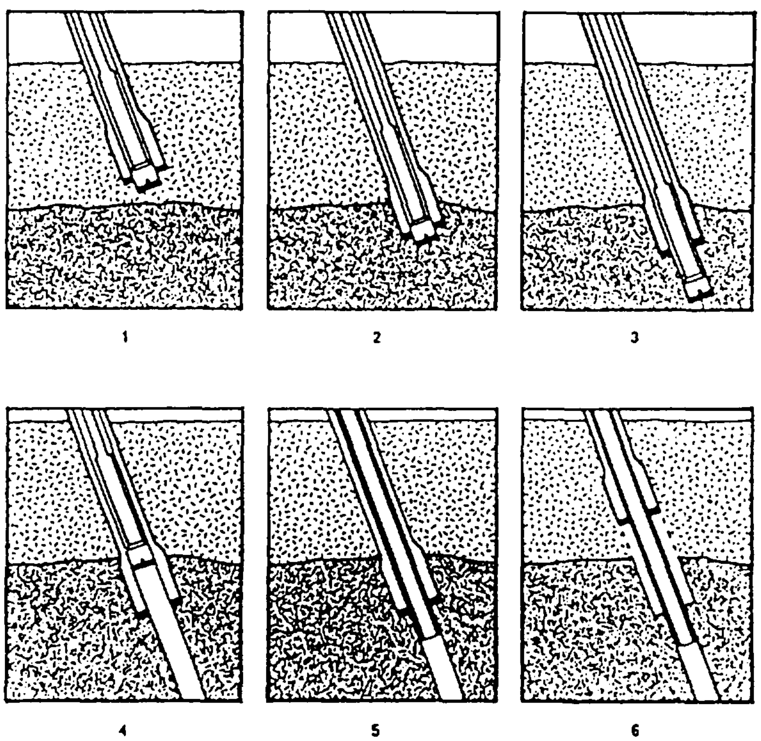

Fig. 19:38 The OD method
1. drilling tubes with ring bit and the extension drill rod are drilled down through the overburden layers
2. the drilling tube is drilled down into the rock
3. the rock hole is drilled with the extension drill steel
4. the extension drill rod is brought up
5. the plastic hose is carried down and is pressed firmly to the rock
6. the drilling tube is taken up and the charge can be fitted via the plastic hose

3 NO. 903-6319	SCALE N.T.S.		
DRAWN EAM	DATE 07/09/90		
CHECKED	DWG. NO.		
Golder Associates		CSX TRANSPORTATION INC.	FIGURE

152078

The whole system is connected to the rock drill by a special shank adapter, which transfers both impact force and rotary force to the string of casing tubes and to the string of extension steels.

Both the inner extension equipment and the outer tube equipment are connected to the adapter and drilled down by impact and rotation. The outer equipment can be disconnected from the adapter and drilling can then be continued as ordinary extension drilling with the inner equipment.

Because the outer tubes are drilled down by impacts, they must be of high quality. The tubes are threaded and are joined together by means of tube couplings. As a rule, the outer equipment together with the bit is far too expensive to be left behind in the hole as a lining. When OD-drilled holes are charged, a plastic hose is placed inside the tubes, which are then recovered for further use.

The friction between the outer tubes and the walls of the hole increases as the hole becomes deeper. Consequently, a high-torque hammer is required, such as a BBE 57 or a BBE 53. In most cases, the torque of the hammer is the factor that limits the depth of the hole.

OD is available for drilling with top hammers. The inside diameter of the outer equipment is 72 millimetres.

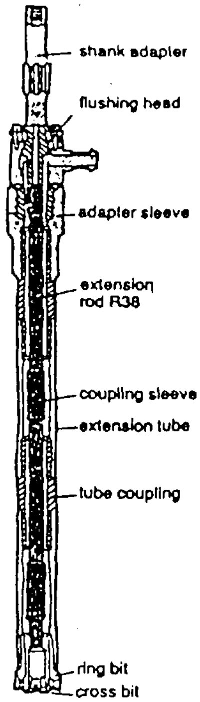

Fig. 19:39 OD-drill

Flushing

Water is normally used as the flushing medium, although air can also be used. If the friction of the soil against the pipes becomes too great, the use of foam may facilitate drilling. On many occasions it is necessary to increase the amount of flushing medium, in which case separate flushing is used. The flushing medium is then introduced into the space between the outer tubes and the extension drilling equipment. The pressure of the flushing medium when separate flushing is used may not exceed the pressure of the flushing medium in central flushing; otherwise, there is a risk that cuttings will penetrate up through the central flushing hole and into the drill itself. When drilling in certain compact overburdens the penetration rate can be improved if the cuttings are evacuated between the OD-tube and the extension drill steel string and then removed through the flushing head.

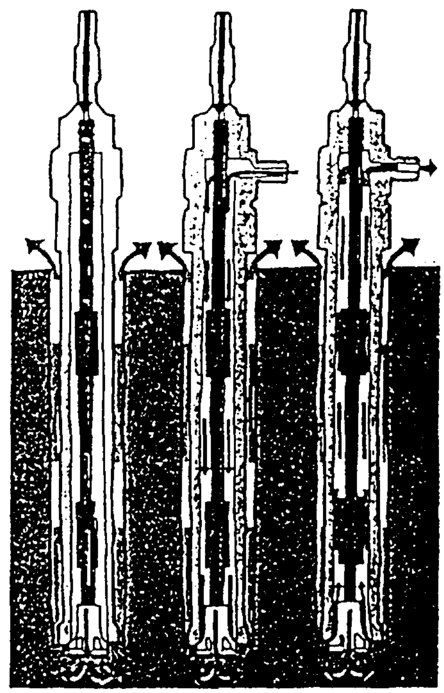
Fig. 19:40 Flushing

JOB NO. 903-6319	SCALE N.T.S.			
DRAWN EAM	DATE 07/09/90			
CHECKED	DWG. NO.			
Golder Associates		CSX TRANSPORTATION INC.	FIGURE	

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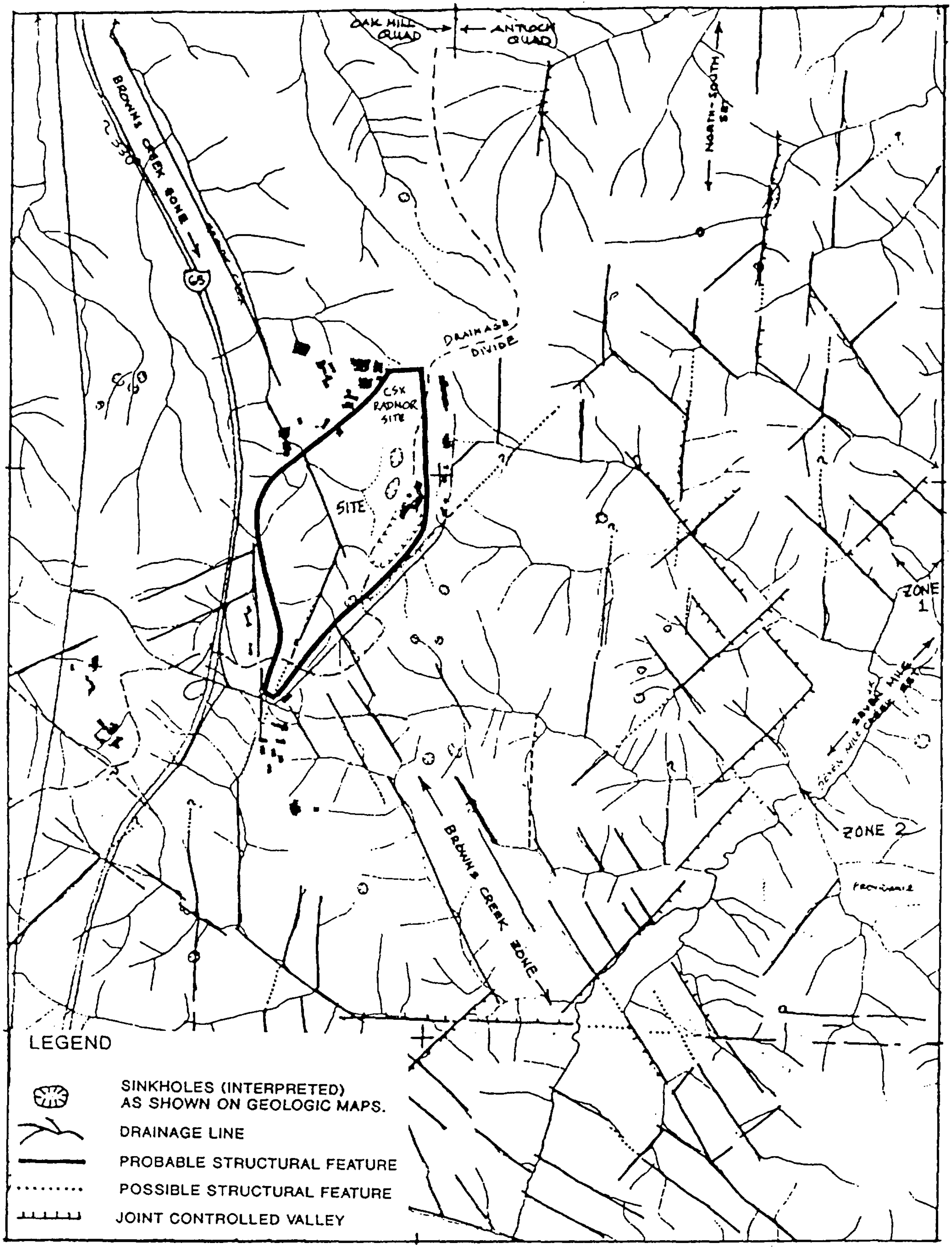
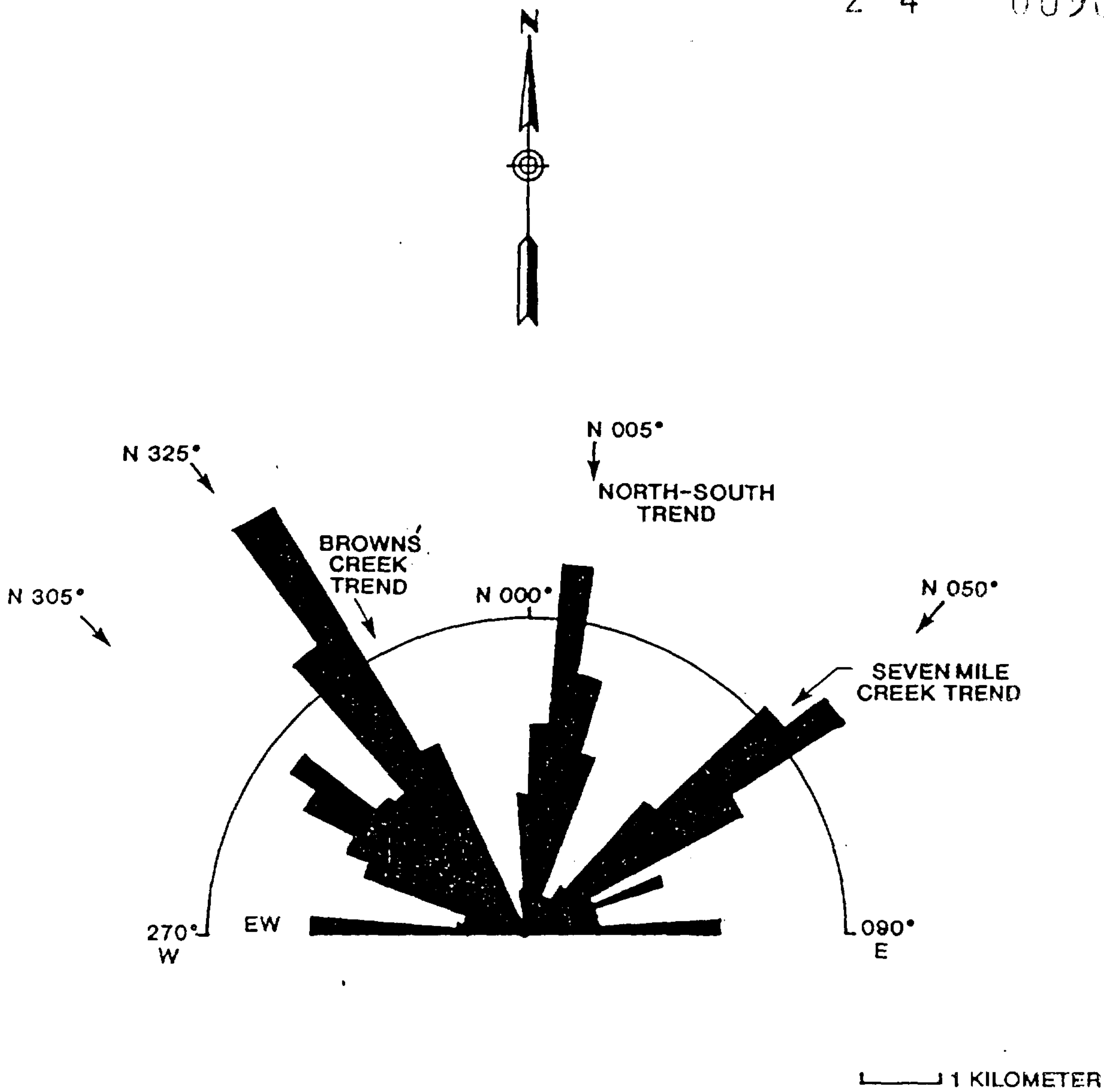


JOB NO. 903-6319	SCALE N.T.S.	**DRAINAGE PATTERN AND TOPOGRAPHIC LINEATIONS**		
DRAWN RB	DATE 07/07/90			
CHECKED	DWG. NO.			
Golder Associates		CSX TRANSPORTATION INC.	FIGURE 2.3-3	

152078

2 4 0090



DRAINAGE LINES INTERPRETED ON U.S.G.S. 7.5 MINUTE SERIES TOPOGRAPHIC, ANTIOCH AND OAK HILL TENNESSEE QUADRANGLES, DATED 1983

MINIMUM SEGMENT LENGTHS COUNTED=1 KILOMETER

JOB NO. 903-6319	SCALE N/A	RECTIFIED DRAINAGE TRENDS LENGTH WEIGHTED	
DRAWN LAS	DATE 07/07/90		
CHECKED	DWG. NO.		
Golder Associates		CSX TRANSPORTATION INC.	FIGURE 2.3-4

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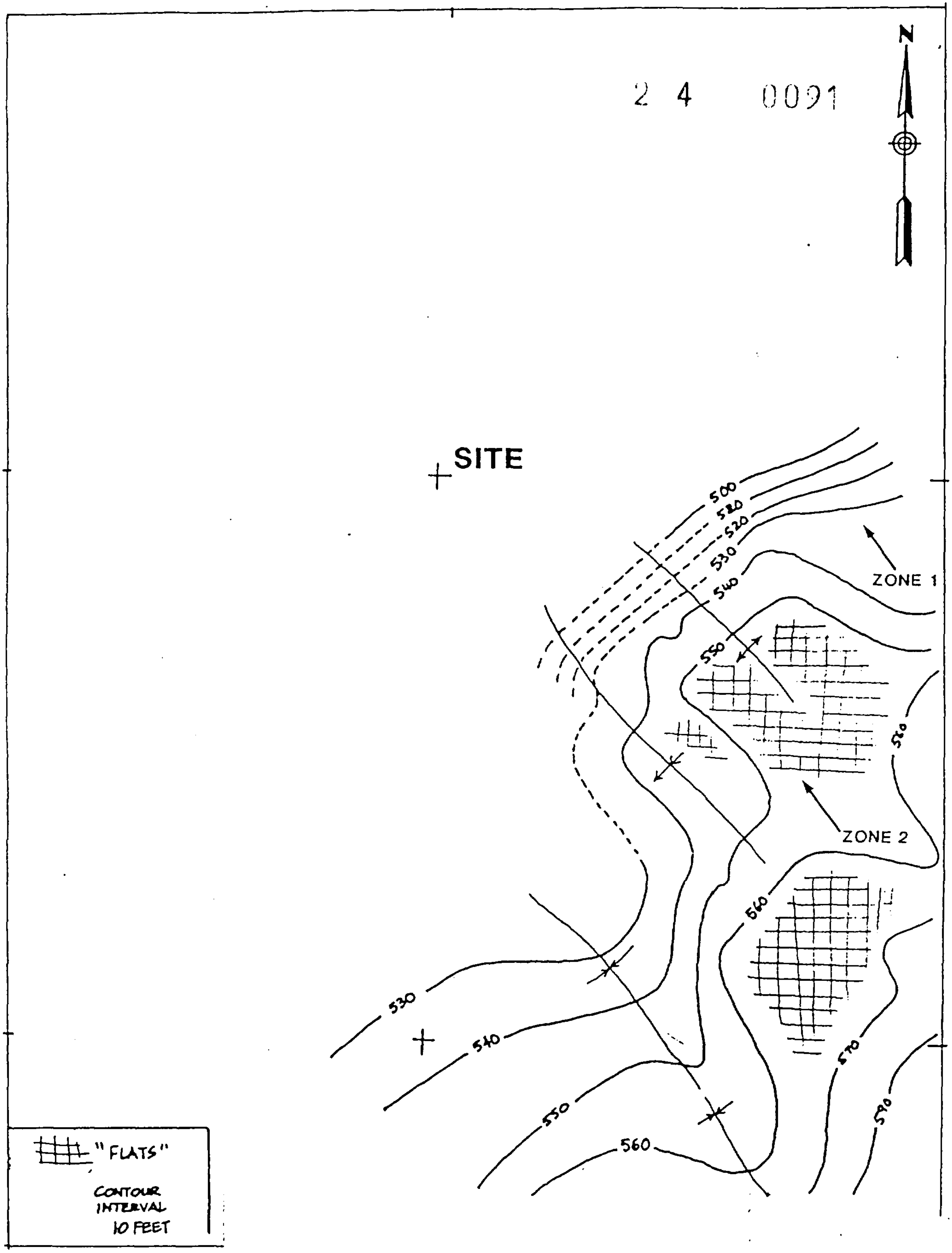
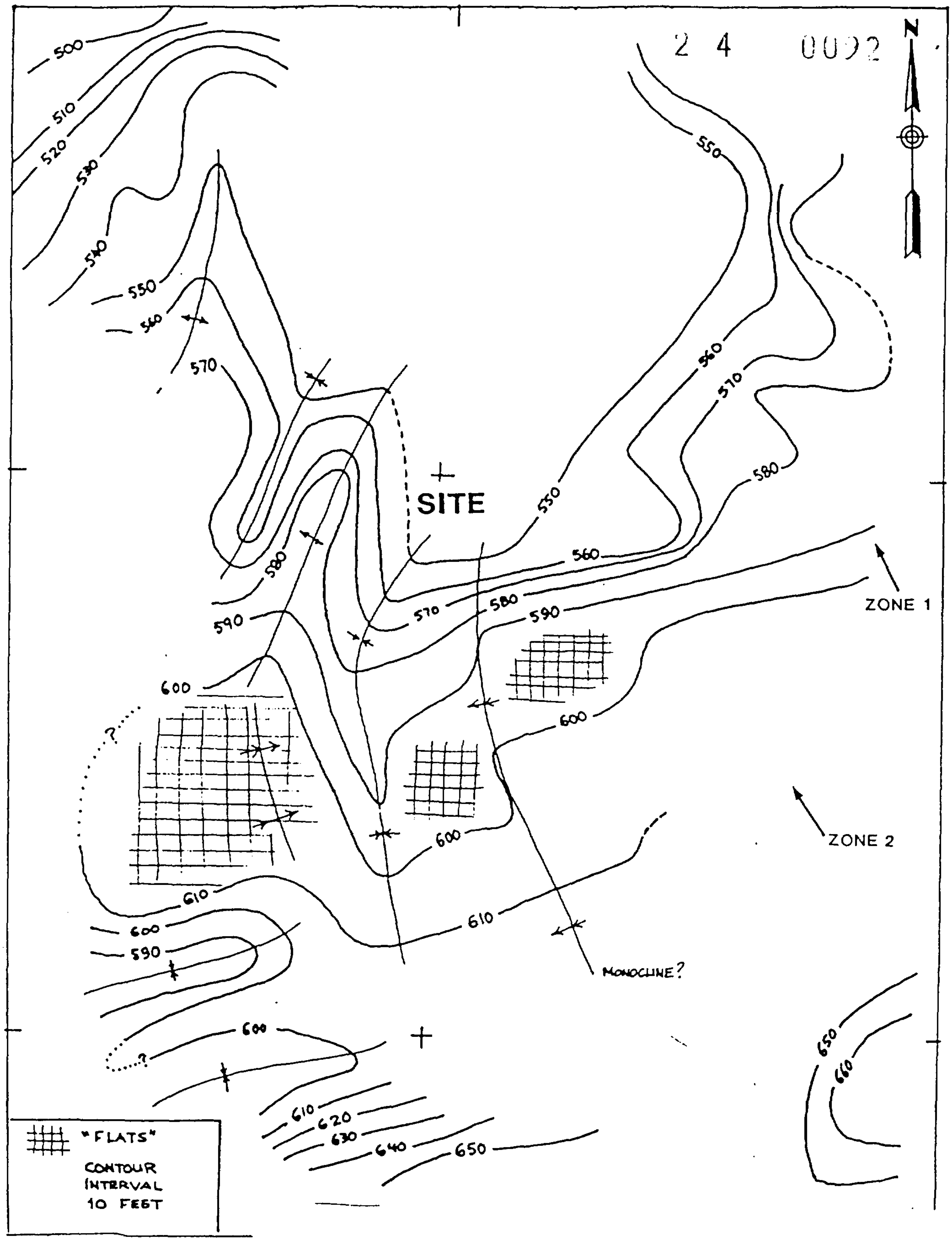
2 4 0091



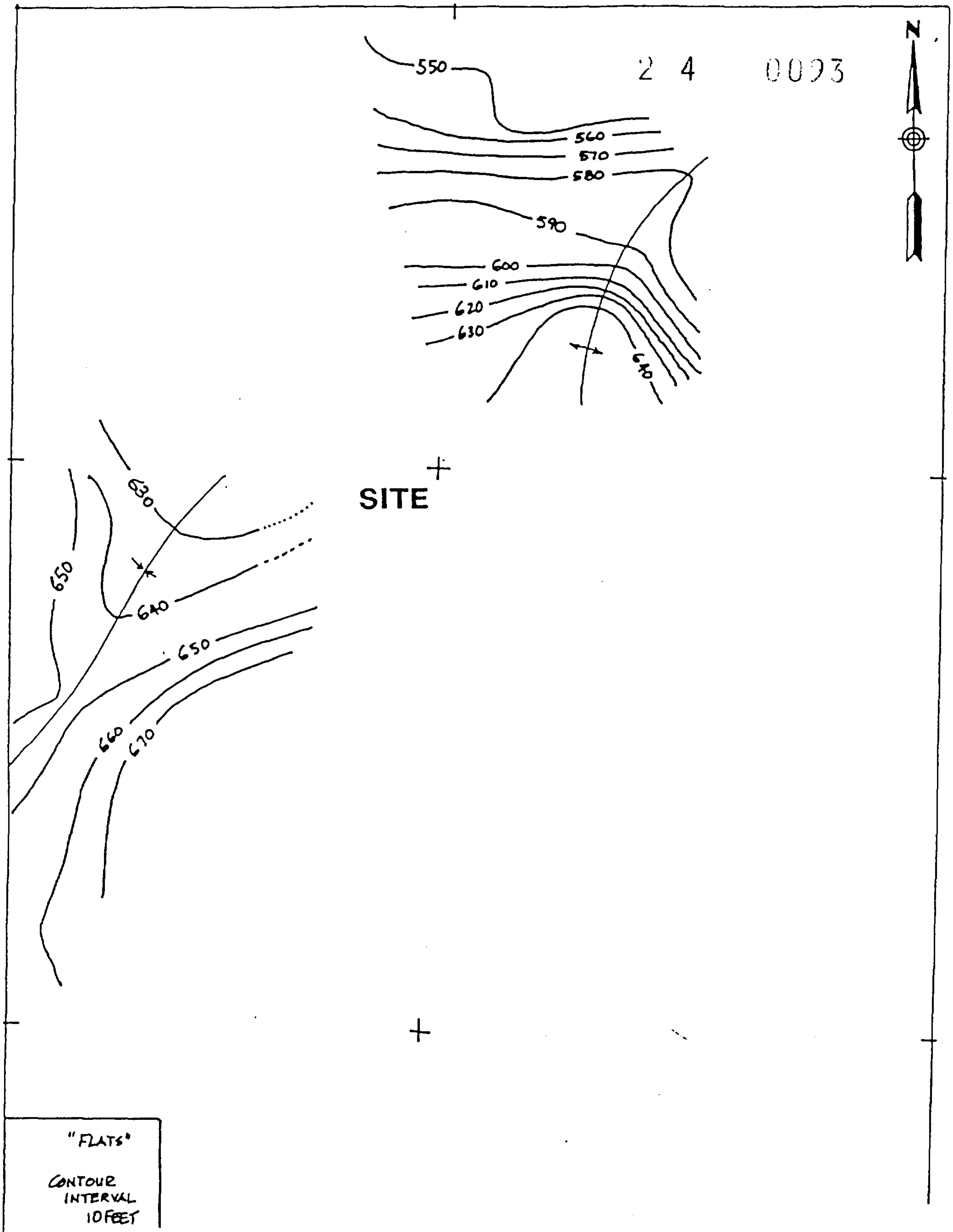
JOB NO. 903-6319	SCALE N.T.S.	STRUCTURAL CONTOURS TOP OF CARTERS LIMESTONE	
DRAWN RB	DATE 07/07/90		
CHECKED	DWG. NO.		
Golder Associates		CSX TRANSPORTATION INC.	FIGURE 2.3-5

152978



JOB NO. 903-6319	SCALE N.T.S.	STRUCTURAL CONTOURS TOP OF HERMITAGE FORMATION
DRAWN RB	DATE 07/07/90	
CHECKED	DWG. NO.	
Golder Associates		CSX TRANSPORTATION INC. FIGURE 2.3-6

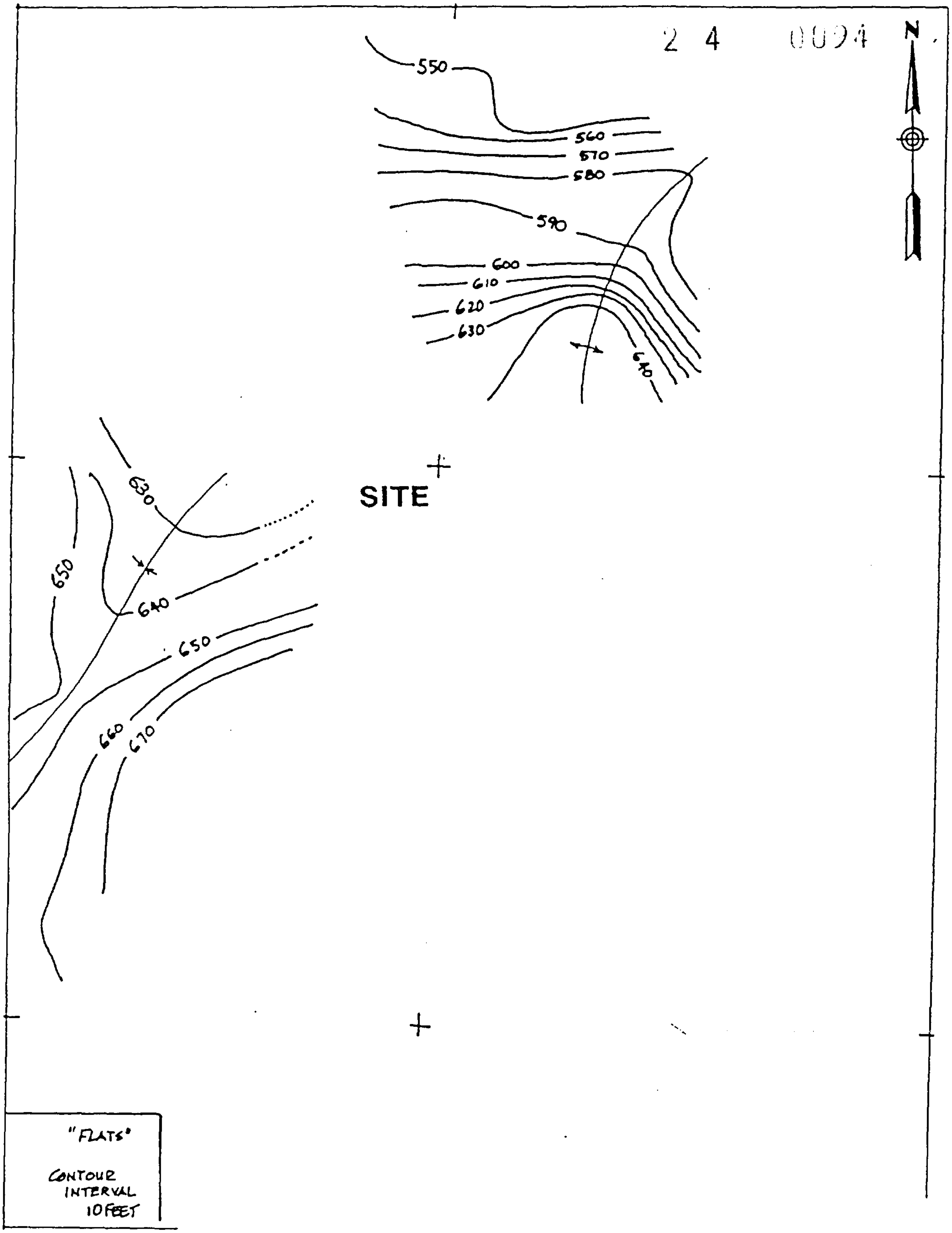
152078



2 4 0093

JOB NO. 903-6319	SCALE N.T.S.	STRUCTURAL CONTOURS TOP OF BIGBY-CANNON FORMATION	
DRAWN RB	DATE 07/07/90		
CHECKED	DWG. NO.		
Golder Associates		CSX TRANSPORTATION INC.	FIGURE 2.3-7

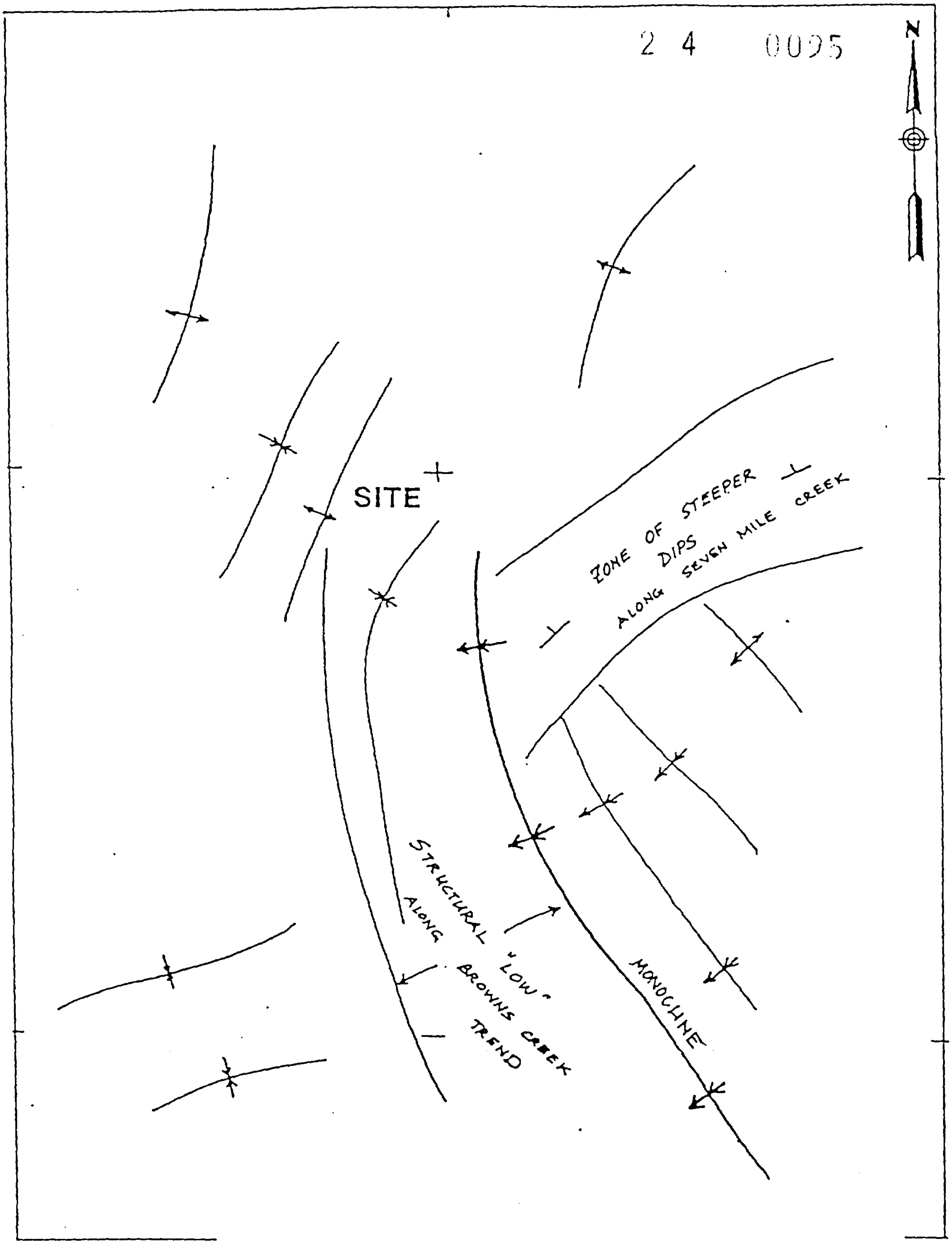
152978



JOB NO. 903-6319	SCALE N.T.S.	STRUCTURAL CONTOURS TOP OF BIGBY-CANNON FORMATION	
DRAWN RB	DATE 07/07/90		
CHECKED	DWG. NO.		
Golder Associates		CSX TRANSPORTATION INC.	FIGURE 2.3-7

152978

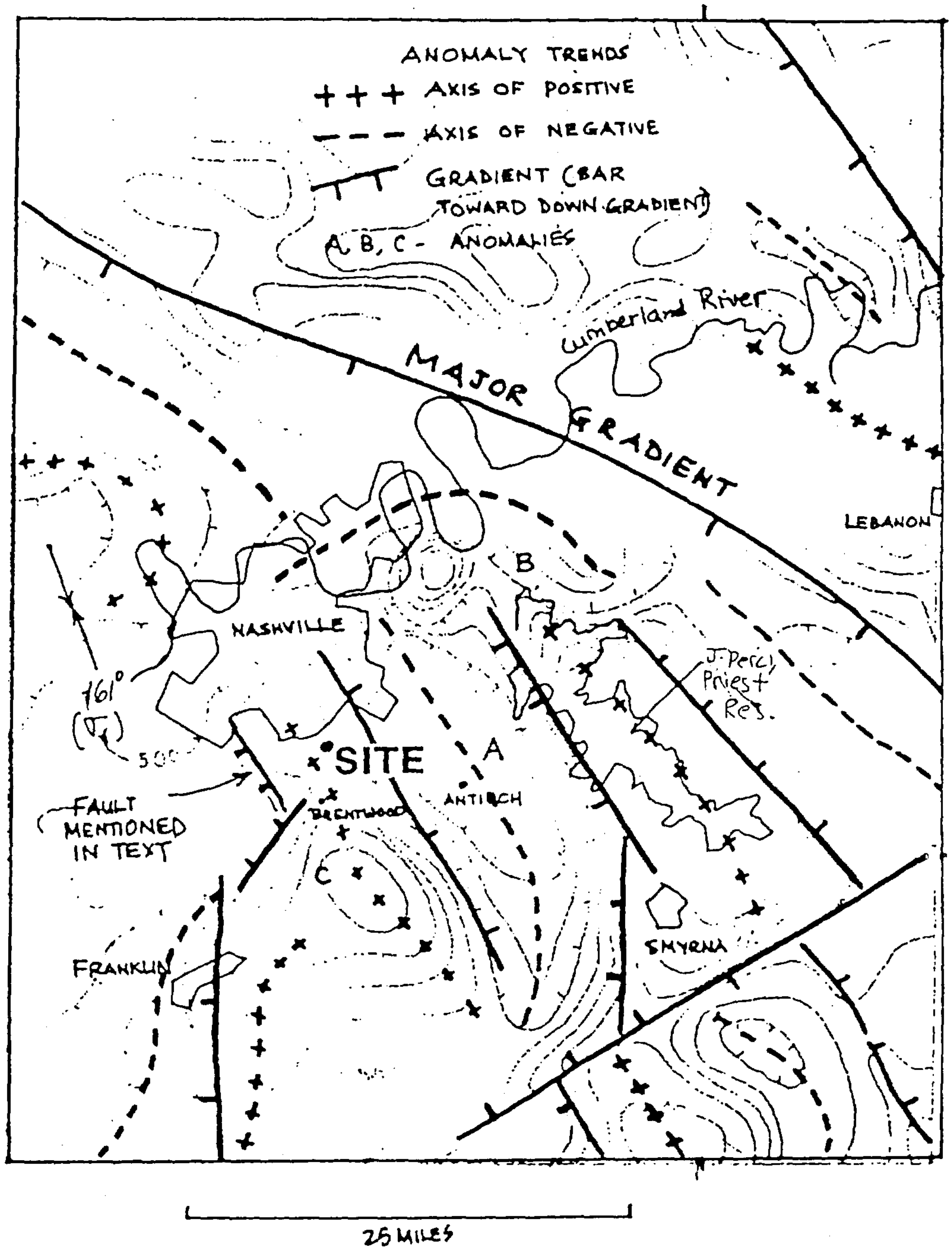
2 4 0095



JOB NO. 903-6319	SCALE N.T.S.	GENERALIZED STRUCTURAL INTERPRETATION
DRAWN RB	DATE 07/07/90	
CHECKED	DWG. NO.	
Golder Associates		CSX TRANSPORTATION INC. — FIGURE 2.3-8

152978

2 4 0026

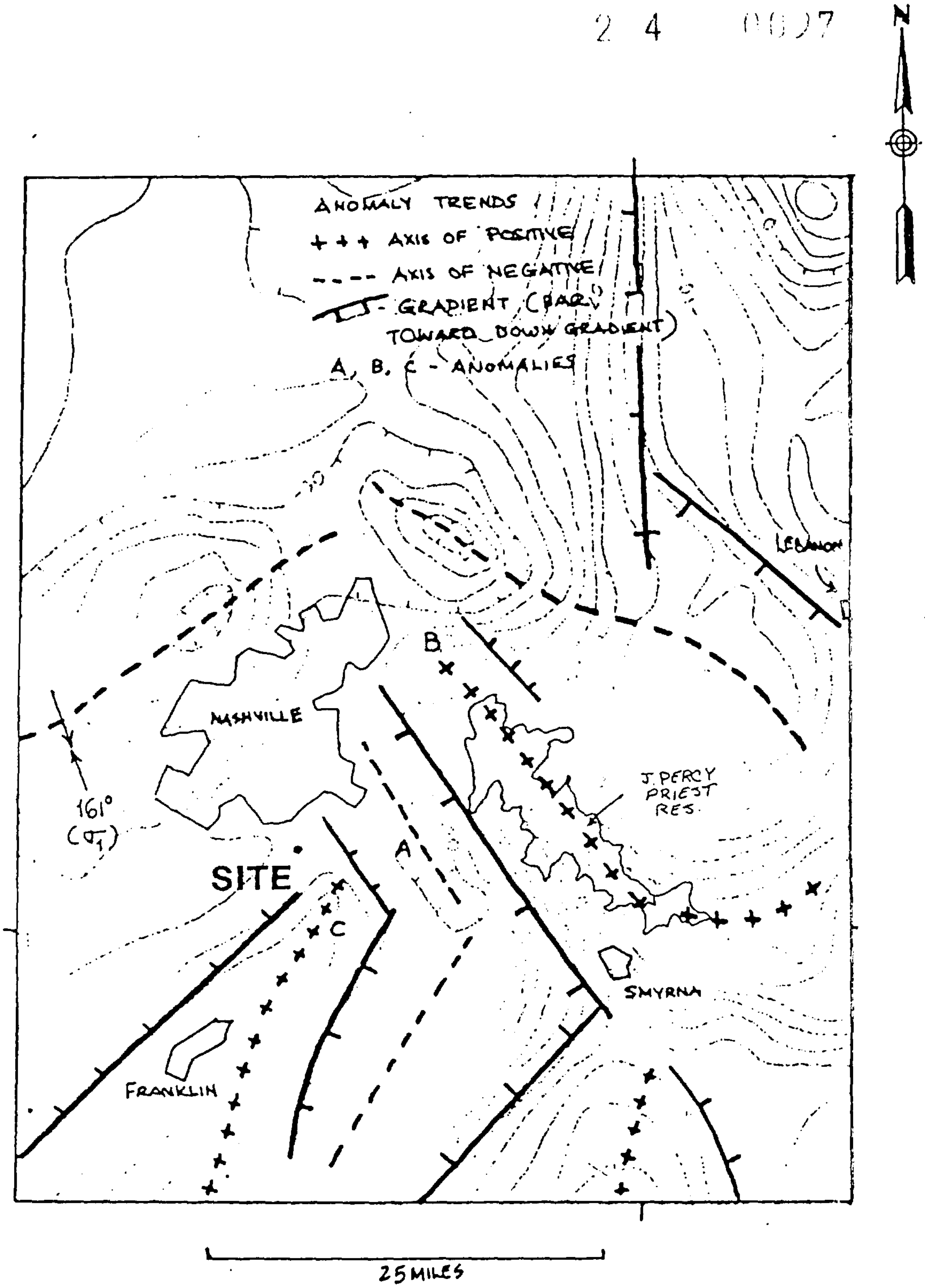


BASED ON MAXIMUM COMPRESSIVE STRESS PRINCIPAL AXIS
AS MEASURED IN MISSIPPIAN CARBONATES

JOB NO. 903-6319	SCALE N.T.S.	INTERPRETIVE AEROMAGNETIC MAP		
DRAWN RB	DATE 07/07/90			
CHECKED	DWG. NO.			
Golder Associates		CSX TRANSPORTATION INC.	FIGURE 2.3-9	

152978

2 4 0007



BASED ON MAXIMUM COMPRESSIVE STRESS PRINCIPAL AXIS
AS MEASURED IN MISSIPPIAN CARBONATES

JOB NO. 903-6319	SCALE N.T.S.	INTERPRETIVE GRAVITY MAP		
DRAWN RB	DATE 07/07/90			
CHECKED	DWG. NO.			
Golder Associates		CSX TRANSPORTATION INC.	FIGURE 2.3-10	

152978

OVERSIZED

DOCUMENT

(5)

11:45 AM 11/30/90

ED H. HOCKENSMITH, P.E.
PRINCIPAL
OFFICE: (615) 373-5040
FAX: (615) 370-4339
HOME: (615) 377-6032

RESOURCE CONSULTANTS
environmental engineers and scientists

DELIVERY
7121 CROSSROADS BLVD.
BRENTWOOD, TN 37027

MAILING
P.O. BOX 1848
BRENTWOOD, TN 37024

2-4 0103

TO: Jimm

Mason Sinclair

Browns Creek at

Thompson lane

More diesel than usual.

11/30/90 at 8:30 A.M

From JEH

Ferguson harbor service, inc.

12:15pm 11/30/90

KEITH F. BAILEY
Vice President

CORPORATE OFFICE
340 Rockland Road • Hendersonville, Tennessee 37075
24 Hr. (615) 822-3295 • Fax (615) 264-2435

ENVIRONMENTAL • INDUSTRIAL • MARINE

U.S. COAST GUARD
MARINE SAFETY DETACHMENT

11/30/90 1:15pm

HARRY B. HUESTON
MARINE SCIENCE TECHNICIAN

(615) 736-5421
FTS 852-5421

220 GREAT CIRCLE ROAD
SUITE 148
NASHVILLE, TN 37228-1700

CSX TRANSPORTATION
CSX RAIL TRANSPORT

P. O. Box 110038
Woodbine Station
Nashville, TN 37211
(615) 664-2722

mobile 347-8836
Home: 854-1630

F. L. Miracle
General Plant Manager

11/30/90 11:45AM

Chronology of CSX Transportation - Radnor Yard # 2 Diesel Fuel Spill/Fish Kill on November 11, 1990

1. At 8:30 A.M., JEH relayed To JMM that Mason Sinclair of the Nashville Water Services Dept. had reported a substanital amount of diesel fuel in Browns Creek near Thompson Lane and Powell Avenue.

2. JMM arrived at the CSX temporary recovery site directly across from Heafner Tire Co. at 4071 Powell Avenue on the East Fork of Browns Creek. The 3 or 4 booms in place were saturated but the odor of diesel fuel was strong and the pool behind the booms was a dark blue-green color. Also, the product was flowing under the booms in a brown sludge appearance. This was not the normal brown scum behind the booms and obviously CSX had had a major spill or discharge.

3. JMM took a petroleum sample at 9:00 A.M. three feet downstream of the booms and sealed it for legal custody. The sample was then tagged and refrigerated.

4. At 9:15 A.M., JMM went to CSX's Sea Modol office to try to contact Cary Henderson but he was out of town. He left a message with the Sea Modol dispatcher to reach the Yardmaster and waited until 9:45 A.M. with no response.

5. At 10:05 A.M. and 10:20 A.M. respectively, JMM sited the sheen and product on Browns Creek at Thompson Lane and Powell Avenue, at the State Fairgrounds and at the Cumberland Stained Glass Co. just downstream of Browns Creek's flow under Nolensville Road. At the Glass Co., he again tried to reach the Yardmaster and suceeded. He told JMM that he would notify proper personnel and JMM told him that he would be located at the P.I.E. Trucking Co. located at the mouth of Browns Creek since this would probably be CSX's first locale to place containment booms.

6. At 11:45 A.M., Mr Fred Miracle of CSX met JMM and had a containment crew from CSX and their consultant engineer Mr. Hockensmith of Resource Consultants. At that time Mr. Miracle advised JMM they were going to deploy four booms at this site and then go upstream to deploy more booms. I pointed out to him that these booms were not sufficient since the product was seeping under them. He said the idea was to use this area as a secondary containment to keep the product out of the River until Ferguson Harbor Services arrived.

7. At 12:30, JMM went to Dundee Cement Co. about 200 yds. downstream of Browns Creek's entry to the River. He did not see any product in the River at this site.

8. At 1:15 P.M., the U.S.C.G. arrived to take jurisdiction of the spill. This group was lead by Harry Hueston, Marine Science Technician. At this point Mr. Miracle stated that the spill was under investigation and was caused by an opened valve at their 102,000 gallon waste fuel recovery sump or at a lift station to this sump. He belived it was vandalized and estimated 20,000 - 30,000 gallons of # 2 diesel fuel was lost and then accepted resopnsibility for CSX for the incident.

9. At 2:00 P.M., JEH and BHR arrived at P.I.E. and went upstream to take pictures and later returned to the NBO office and informed JMM of a fish kill in the State Fairgrounds area. TWRA had been notified of the fish kill.

CSX Spill/Fish Kill
November 11,1990

10. With U.S.C.G. on scene and U.S.E.P.A. notified, I JMM left the scene. On 12-3-90, the petroleum sample was taken to the State Division of Labs under seal and the proper chain of custody was followed.

John M. McClendon, Chemist II JMM
NBO of WPC
Dept. of Health and Environment

2 4 0106

Put in CSX file

DEC 19 1990

DRAFT COPY

FISH KILL INVESTIGATION

Tennessee Wildlife Resources Agency

Submitted by: Dick Wilson
Title: Biologist
Date: December 7, 1990

1. Body of Water: Browns Creek

2. Nearest town: Nashville County: Davidson

3. Time and date of kill: 11-30-90 early morning

4. Time and date of investigation: 11-30-90 late afternoon

5. Duration of kill: unknown

6. Extent of kill: Stream miles: 1.5 Lake acres:

7. Condition of fish found (check one or more):
   Dead for a short period: X
   Dead for several days:
   Dying and in distress: X
   Other:

8. Symptoms of distressed fish: gasping at surface

9. Abnormal appearance of water: much oil on surface

10. Investigating personnel (give name and organization represented: Dick Wilson, TWRA, Joe Holland, TDWPC

11. Other persons and/or organizations invovled:
    Name and Title Organization and address

Remarks:

2 4 0107 JEH 1/17 BHR 1/17

Emergency Response Report
Tennessee Division of Water Quality Control

A. Initial Report

Date 11/30/90 Time 8:30 A.M. Received By JEH

Reported By Mason Sinclair of Nashville Water Services of Metro/Nashville Government

Material #2 Diesel fuel Location CSX's temporary recover area of E. Fk. Browns Creek

B. Other Agencies Involved

Agency	Contact	Date	Time
(See attached sheet)			

C. Investigation

Investigator(s) JMM; JEH, BHR Date 11/30/90 Time 9AM; 2pm

Material #2 Diesel fuel Quality estimates 20-30,000 gallons

Responsible Party CSX Railroad - Radnor Yard

Contact Fred Miracle - Gen. Plant MNG.

Location CSX's Recovery waste fuel site across from Helper Tire - Powell Ave.

Hazardous Properties low flammability, toxic to biota

Stream and/or Water Supply Involved Browns Creek - East Fk. to Mouth

Situation Description Pool behind CSX's 4 booms not usual brown color but deep blue and sheen with sludge flowing under booms, later causing fish kill and distress in fairground Area.

Protection and/or Clean-up Procedures Recommendation
1st Contact with Mr. Miracle - they (CSX) would be doing own containment until severity of spill was determined later Ferguson Harbor was on scene at request of USCG

Comments Relative to Implementation of Recommended Procedures
Much difficulty in notifing CSX personnel early on about what I (JMM) found at 9 AM., I went directly to Sea Modal (Trailer load area) for assistence - No response.

* D. Expenses

1. Personnel / Time (Hrs.)* / Rate / Total

Personnel	Time (Hrs.)*	Rate	Total
A	7.5	18.22	136.65
B			
C			

*Denote hours overtime in ( ) as part of total.

2. Travel

Miles	Rate ($/mile)	Total
24	0.28/mile	$6.72

3. Miscellaneous

Meals ____________

Phone Calls ____________

Other (Specify) $91.14 per 1988 sheet

1 set of petroleum sample

____

Use back of form for necessary additional information.

bl/3-5 (See attachment)

* Field investigation cost for personnel A only.

FISH KILL INVESTIGATION

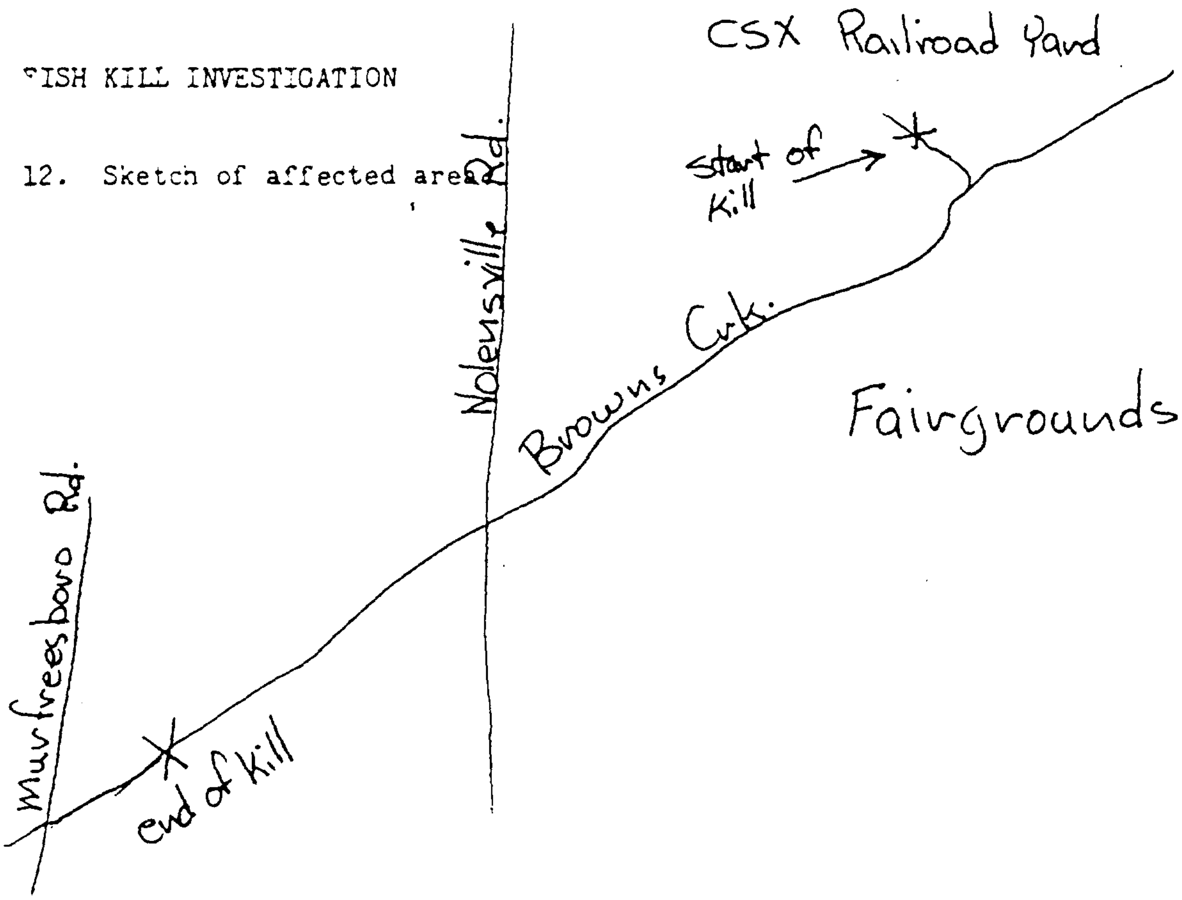
14. Suspected cause of kill: Discharge of petroleum into Browns Creek by CSX railroad yard

15. Discussion: It appears that CSX railroad released an estimated [illegible],000 gallons of petroleum products into Browns Creek. The oil resulted in the loss of numerous fish over an estimated 1.5 miles of stream.

16. Recommendations: Collect damages from the responsible party.

FISH KILL INVESTIGATION

12. Sketch of affected area:



13. Chemical Data:

Sample Point	Sample Depth	Date	Time	D.O.		Temp.	Other Field Tests			Water Samples			

FISH KILL INVESTIGATION

FISHERY LOSS AND EXPENSE

1. Estimate of fish killed and monetary value:

Species	Number	value/fish	Total Value
Minnows/darters	840	$.06	$50.40
3 inch bluegill	41	.47	19.27
TOTALS	881		$69.67

FISH KILL INVESTIGATION

2. Field Investigation expenses:

NAME	HRS.	SALARY	MILES DRIVEN	.22 MI.	BOAT OPER.	FILM
Dick Wilson	4	59.48	.78	18.72		
TOTAL		59.48		18.72		

TOTAL FISHERY VALUE LOST........$69.67

TOTAL EXPENSES...................78.20

GRAND TOTAL.....................$147.87

2 4 0113

DEC 31 1990

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
ENVIRONMENTAL LABORATORIES
ORGANIC ANALYSIS,EXTRACTABLES

Sample Type: LIQUID
Sample Site Code:
Sample Source: W. FK. BROWN'S CRT A/S CSX BOOMS
County: 19
Field No:
Collected-Date 11/30/90 Time 09:00 By JMM
Date Priority Needed 12/17/90

Laboratory Number 90-12-0001
Branch Lab Number
Received-Date 12/03/90 Time 12:47 By LLR
Sampling Agency: WPC/
Sample Priority:
Emergency[N]Legal[Y]Routine[N]Ambient[N]

CODE	BASE/NEUTRAL EXTRACTABLES	VALUE*
34292	BUTYLBENZYL PHTHALATE	
39100	BIS(2-ETHYLHEXYL)PHTHALATE	
39110	DI-N-BUTYL PHTHALATE	
34596	DI-N-OCTYL PHTHALATE	
34336	DIETHYL PHTHALATE	
34341	DIMETHYL PHTHALATE	
34438	N-NITROSODIMETHYLAMINE	
34433	N-NITROSODIPHENYLAMINE	
34428	N-NITROSO DI-N-PROPYLAMINE	
34408	ISOPHORONE	
[illegible]447	NITROBENZENE	
[illegible]11	2,4-DINITROTOLUENE	
34626	2,6-DINITROTOLUENE	
34205	ACENAPHTHENE	
34200	ACENAPHTHYLENE	
34220	ANTHRACENE	
34526	BENZO(a)ANTHRACENE	
34247	BENZO(a)PYRENE	
34230	BENZO(b)FLUORANTHENE	
34521	BENZO(ghi)PERYLENE	
34242	BENZO(k)FLUORANTHENE	
34556	DIBENZO(a,h)ANTHRACENE	
34376	FLUORANTHENE	
34381	FLUORENE	
34403	INDENO(1,2,3-cd)PYRENE	
34696	NAPHTHALENE	
34461	PHENANTHRENE	
34469	PYRENE	
34320	CHYRSENE	
34273	BIS(2-CHLOROETHYL)ETHER	
34278	BIS(2-CHLOROETHOXY)METHANE	
34283	BIS(2-CHLOROISOPROPYL)ETHER	

CODE	BASE/NEUTRAL EXTRACTABLES	VALUE*
34636	4-BROMOPHENYLPHENYL ETHER	
34641	4-CHLOROPHENYLPHENYL ETHER	
34386	HEXACHLOROCYCLOPENTADIENE	
34391	HEXACHLOROBUTADIENE	
39700	HEXACHLOROBENZENE	
34396	HEXACHLOROETHANE	
34551	1,2,4-TRICHLOROBENZENE	
34581	2-CHLORONAPHTHALENE	
39330	ALDRIN	
39337	ALPHA BHC	
39338	BETA BHC	
34259	DELTA BHC	
39340	GAMMA BHC(LINDANE)	
39350	CHLORDANE	
38310	4,4 DDD	
39320	4,4 DDE	
39300	4,4 DDT	
39380	DIELDRIN	
34361	ENDOSULFAN I	
34356	ENDOSULFAN II	
34351	ENDOSULFAN SULFATE	
39390	ENDRIN	
34366	ENDRIN ALDEHYDE	
39410	HEPTACHLOR	
39420	HEPTACHLOR EPOXIDE	
39400	TOXAPHENE	
39480	METHOXYCHLOR	
	PCB 1016/1242	
39488	PCB 1221	
39492	PCB 1232	
39500	PCB 1248	
39504	PCB 1254	

CODE	BASE/NEUTRAL EXTACTABLES	VALUE*
39508	PCB 1260	
81649	PCB 1262	

CODE	ACID EXTRACTABLES	VALUE*
34552	4-CHLORO-3-METHYL PHENOL	
34586	2-CHLOROPHENOL	
34601	2,4-DICHLOROPHENOL	
34606	2,4-DIMETHYLPHENOL	
34616	2,4-DINITROPHENOL	
34657	2-METHYL-4,6-DINITROPHENOL	
34591	2-NITROPHENOL	
34646	4-NITROPHENOL	
39032	PENTACHLOROPHENOL	
34694	PHENOL	
34681	2,4,6-TRICHLOROPHENOL	

	OTHERS	
	GASOLINE	ND
	DIESEL FUEL	*
	KEROSENE	ND

*Reporting Units, unless otherwise noted:
water, ug/l; sediment,ug/kg;fish,mg/kg

Unit supervisor Jerry W. Bingaman
Date 12-12-90

Completed-Date:12/03/90 Time: By:JWB

Signature of supervisor indicates that the work was performed in accordance with federally approved procedures where available and in compliance with current quality assurance criteria except as qualified.

Comments:: *PEAKS INDICATIVE OF DIESEL FUEL PRESENT IN SAMPLE

PH-3016LAB(REV 5/90)